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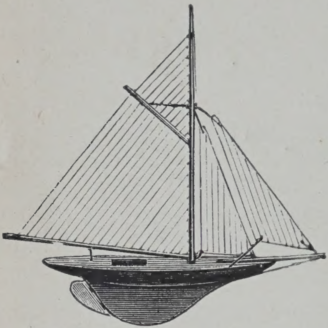

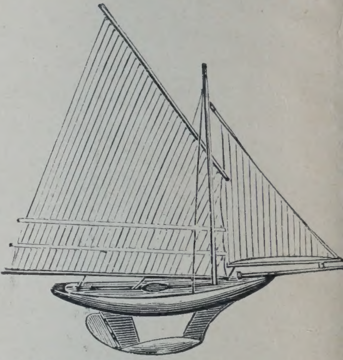

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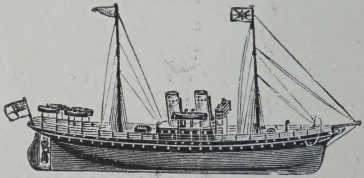

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PUBLISHER'S NOTE

THIS short treatise on Building Model Boats is issued in the confident belief that it is not only thoroughly practical and reliable, but is so simply worded that even inexperienced readers can understand it. Should anyone, however, encounter unexpected difficulty, he has only to address a question to the Editor of WORK, La Belle Sauvage, London, E.C.4, and his query will be answered in the columns of that journal.

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BUILDING MODEL BOATS.

CHAPTER I.

BUILDING MODEL YACHTS.

MUCH space in a handbook on practical model boat building must necessarily be devoted to the model sailing yacht or cutter, as that type of model craft is the one most often met with. This handbook will, therefore, deal first with the construction, rigging, and sailing of model yachts, and then proceed to treat on other craft, including the simpler sailing models and an up-to-date steamship model.

The construction of a model yacht does not necessitate an acquaintance with either ship or boat building; on the contrary, it may be encouraging to know that many excellent models have been made by persons who were entirely unacquainted with the principles of either of the afore-mentioned occupations.

A model may be rigged either as a cutter, yawl, lugger, schooner, brig, barque, or even ship; the amount and position of the rigging will, however, have much to do with the immersed portion. Inasmuch as sailing models are expected to manage themselves when afloat, yards and square sails should be avoided, thus necessitating a choice being made of either a cutter, yawl, schooner, lugger, or lateen.

A cutter, which has a long, overhanging stern, carries a tall mast placed perpendicularly, at a distance of about one-third the length of the boat abaft the stem; it is also usual to carry two other sails, the jib and foresail. In light winds a gaff-topsail is set above the mainsail, a balloon jib being set forward.

The only difference between a cutter and a yawl rig is that for the latter the mainsail is made narrower at the foot, and that a short additional mast and sail are placed right aft. This short mast is of great advantage in balancing the amount of sail that is set.

A schooner is not so broad in proportion to its length as is the cutter. Two masts are required—a foremast placed nearer the stem than in the cutter and yawl, and a mainmast a little abaft the half length of the boat. Fore and mainsails are carried, two jibs being set forward. For light winds, balloon, jib, and gaff-topsails are carried extra. A cutter, yawl, and schooner will be illustrated later on. A lugger carries two standing lugs and a jib.

The lateen possesses the disadvantage of dipping. A lateen sail, which is triangular in shape, has its upper edge fastened to a long yard, inclined at an angle of 45°. The yard is slung at a point threequarters of its length from the peak end.

So long as reasonable proportion is maintained, there is no limit to the size a sailing model may be made; but, in determining the dimensions, care must be taken to design one not less than 2 ft. long. In most cases the beam or breadth may be reckoned as about one-fourth the length, and the depth, exclusive of lead keel, about three-fourths of the beam. A large model is preferable to a small one, because increased length gives increased speed, greater beam allows more sail to be carried without undue inclination, and a greater depth permits of a more direct course being kept by presenting greater lateral resistance to the water.

Before commencing any work a plan must be prepared, showing all the dimensions which it is intended to observe in constructing the model. For a cutter, let the plan be based upon a 2 ft. 6 in. length, which will represent a vessel 2 ft. 8 in. over all, having a total breadth of 8 in., and a depth, without the lead keel, of 6 in. For a schooner an approximate length of 4 ft. may be taken as a basis; this will mean 10 in. beam and 7½ in. depth.

In deciding the shape of the yacht, arrange to diminish the resistance offered to the hull, the object being to attain as much speed as possible, and this is largely helped by diminishing the resistance offered by the vessel on her passage through the water. The fore end, or entrance of the vessel, instead of being bluff, must be so arranged as to cut through the water almost silently; and the aft (called the run or delivery) must also be well shaped, otherwise the speed and steerage will be embarrassed by an unnecessary eddy.

In shaping the midship section, a slight hollow close to the keel will make a satisfactory connection. The part above the water-line should fall in very little, if any, as a full upper body will prevent too much inclination when the boat is under sail.

In designing the model, the requisites will be: A sheet of "double elephant" drawing paper (40 in. by 27 in.), a drawing-board which will accommodate the paper, a T-square, two or three set-squares, some drawing-pins, a 3-ft. straightedge, a few French curves of various designs, a pair of 5-in. dividers, a 2-ft. rule, and three drawing battens; two of these must be 30 in. long, tapered from a ¼ in. square at one end to ¼ in. by $\frac{1}{16}$ in. at the other, and the third is to be about 42 in. long, ¼ in. square in the middle, tapered at both ends to ¼ in. by $\frac{1}{16}$ in. About a dozen lead weights will be necessary for use with the battens, these to be in blocks 5 in. by 2 in. by 1½ in. On one of their narrow sides they will need to be faced with hard wood, the facing to have a tapered ledge or projection ¾ in. long at one end, to rest upon the batten.

The first step necessary in designing a model yacht is to make drawings to show the "sheer-plan" (Fig. 1); "half-breadth-plan" (Fig. 2); and "body-plan" (Fig. 3). Stretch the "double elephant" sheet properly on a drawing-board, drawing a vertical line exactly up the centre, mark off 1 ft. 4 in. on each side, and erect the perpendiculars A and B. The horizontal

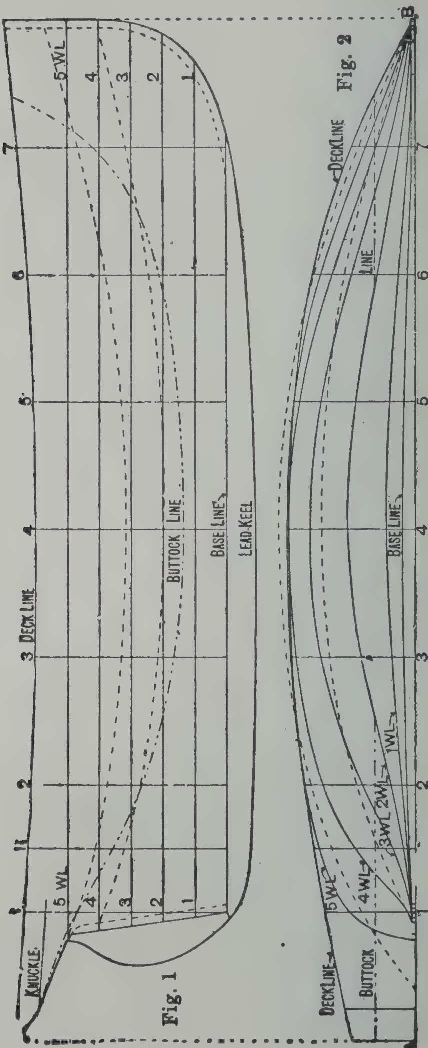


Fig. 1.—Sheer-plan of Model Yacht; Fig. 2.—Half-breadth Plan of Model Yacht.

centre-line A B may then be drawn 24 in. below the top edge of the paper.

With this line as a basis, draw the base-line of the body-plan at a point 5 in. above A B, and the base-line of the sheer-plan 13½ in. above. On the centre-line of the half-breadth plan, locate the points 1, 2, 3, 4, 5, 6, and 7 4 in. apart, and draw up vertical lines from each, about 4 in. long; corresponding vertical sections are drawn on the sheer-plan at the same time, the sheer-plan being, of course, exactly above the half-breadth plan. An intermediate line, numbered "1½," is inserted between sections 1 and 2 to assist in fairing the stern-lines.

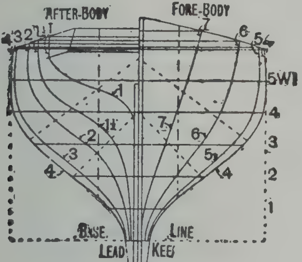


Fig. 3.—Body-plan of Model Yacht.

Section-lines 3 and 5 may be drawn straight through to the top, thus giving the side-lines for the body-plan, the width of which will thus be 8 in. The heights of the deck-line should next be gauged above the base-line of the sheer-plan, the lowest point of the deck being at section-line 4, where it is only 6 in.; at the aft perpendicular it is 6⅝ in., and at the fore perpendicular 7 in. The long batten must now be brought into use. Placing it so that its narrow edges are vertical, set it to the mark on No. 4, secure it by a weight, fix the fore end to No. 6 and the fore perpendicular, and the aft end on No. 2 and the aft perpendicular. When the batten is properly adjusted to the correct points, draw the deck-line lightly but distinctly, and transfer the heights to the body-plan. This can best be done by using a slip of paper about 9 in. long and ½ in. wide; many such slips will be required before the design is complete. Vertical sections 1, 1½, 2, 3, and 4 can be marked on one side of the slip, the fore heights being copied on to the other. Transfer the points to the body-plan, and draw horizontal lines through each spot to the side-lines, No. 4 (the midship one) being drawn right across. On each side of the centre-line allow ⅛ in. to equal half the width of the stem and stern-posts, and draw the vertical lines as shown on the plan.

To draw the deck line on the half-breadth plan, measure the distances from centre at each section, and set off four times that size, the greatest half-breadth on deck (No. 4) being kept $\frac{1}{16}$ in. less than half the width of the boat. Set off the half-width of the stern as before, and the length ¼ in. abaft the fore perpendicular, after which the batten may be used on its narrow side, and the deck-line drawn exactly as in the case of the sheer-plan. The half-breadths of each section may then be transferred from the centre-line by the aid of another slip of paper; the same distances should be set off on the horizontal lines of the body-plan, care being taken that each half-breadth is on its own line. The intersecting curves, shown by Fig. 2, should be drawn by the aid of the wood curves.

Water-lines 1, 2, 3, 4, and 5 should next be set up on the sheer-plan, these being drawn 1 in. apart. Measure with another slip the distances of the front of stem before No. 7 vertical section on the base-line and water-lines 1, 2, and 3; the line will meet the perpendicular at No. 4 water-line. Set these off on the full-size plan, but do not draw the line until the lower edge of the lead keel is approximately shown. The depths of the keel-line below the base-line having been set down, from No. 1½ to 7 inclusive, draw the line lightly by the aid of batten and weights; turn the board round and make the stern-line, the stem-line being also drawn through the spots whilst the board is in its fresh position. The inside line is drawn from the deck to the base-line $\frac{1}{4}$ in. in all the way. In putting in the stern, the knuckle-line is set $\frac{5}{8}$ in. below the deck-line and parallel to it, and 1 in. in from the aft perpendicular. Draw the sloping line from deck to knuckle, gauge on No. 5 water-line a point $\frac{7}{8}$ in. abaft No. 1 section, and draw through it the counter-line from the extremity of the knuckle, the line in question being slightly curved. To set the rake of stern-post, measure the distance from No. 1 section to where the aft side of the post cuts No. 4 water-line, draw a straight line up from the intersection of No. 1 with the base-line, and another one $\frac{1}{4}$ in. within and parallel to it to represent the fore-side of stern-post. Square down on to the half-breadth plan the aft extremity of the knuckle, and, at the centre, the points where the base-line and water-lines terminate on the fore-side of stern-post. In the same manner square down at the fore end, showing where the said lines meet the after-side of stem, represented by the inside line. The outline of stem and rake of stern-post may be modified if desired, but any alteration on the sheer-plan will, of course, affect the half-breadth plan. If the boat is intended for racing purposes, the stern-post may be advantageously set at right angles to the load water-line; if not, the appearance will be improved by setting it otherwise. After deciding this matter, set off the half-breadth at midship section, $\frac{3}{8}$ in., and allow half the thickness of stem and stern-post at each end. Set the batten, and draw the base-line on the half-breadth plan, curved so as to give the keel a firmer hold. By the aid of another slip transfer the half-breadths of base-line to the body-plan, setting off Nos. 4, 5, 6, and 7 to the right of centre line, and Nos. 4, 3, 2, 1½, and 1 to the left.

To set out the midship section, commence by making a pencil line on the centre-line of body-plan $\frac{3}{8}$ in. above base-line, and on each of the vertical side-lines a similar mark 3½ in. above base-line, or midway between water-lines 3 and 4. Draw straight lines from the first point to each of the others, the "rise-lines" of the section being thus obtained; and by running a horizontal line across the body-plan, midway between water-lines 1 and 2, or 1½ in. above base, and another ¼ in. below No. 3 water-line, or 2¾ in. above base, the points at which the section-line begins to curve will be found. On No. 1 water-line set off points ⅞ in. each side of centre, on No. 3 at 3 5/16 in., and on No. 4 at 3 15/16 in. Make points on the vertical side-lines halfway between Nos. 4 and 5 to represent the point where the midship section meets the side-lines. Use French curves to draw the lower part from the base to where it intersects the rise-line, taking pains to try them until the exact one is found. The upper part has now to be drawn from the deck downwards, and this may be done either by the designer turning the board or altering his own position so that he can see the spot where the section meets the rise-line. Finish one section before attempting the second, carefully testing the half-breadths on each water-line to see that they correspond.

To draw the stern-line on the body-plan, take its extreme breadth from the half-breadth plan, and its height from the sheer-plan; prick off these two points on the centre-line and draw a line to join them, representing the port side of stern at deck, parallel to which may be drawn a line representing the extremity of the counter.

Set off the buttock-line on the half-breadth plan, 1¼ in. from centre-line, and extend it from the aft perpendicular until it cuts the deck-line forward. The same line must be shown on the body-plan also, 1¼ in. each side of centre, vertical lines being struck from base-line to deck, intersecting the midship section between water-lines 1 and 2. To show the buttock-line in elevation on the sheer-plan, measure on the illustration the height above base-line where the buttock-line crosses each section, and set these off on the plan being made. The correct dimensions can be ascertained by remembering that the illustrations (where not otherwise stated) are to a scale of 2 in. to the foot. Test with the dividers whether the height above base for the midship one corresponds with that shown on the body-plan ; if not, the height on sheer-plan must be made to agree. Square up from the half-breadth plan to the sheer-plan the point where the buttock-line meets the deck-line forward. Draw in the buttock-line in elevation by aid of the long batten and weights, the batten being used on one of its narrow sides, as in drawing the deck-line. The line will terminate, of course, at the knuckle aft. It must be drawn exactly through the points at the midship section and ends. By taking pains in properly adjusting the weights the batten can be bent to catch all the intermediary ones. In case it may have deviated from the points which it should have passed through, lift the actual heights above base from the line itself, this being done by using another slip ; and transfer to buttock-line on body-plan the heights just taken.

The fore and after-body measurements should be kept separate in all cases where heights or breadths are thus taken. Sketch lightly in freehand on the body-plan the form of each section. Commence at the proper point on deck-line, pass through that on buttock-line, and bring each down to its own place on the base ; or, to secure accuracy, take from the illustration the points where the sections intersect water-lines 2 and 4, and set them off on the full-size drawing before sketching in the approximate shape of each. This done, transfer from body-plan to half-breadth plan the approximate position of each of the sections. Use slips for this purpose, applying one first to water-line 5, then to 4, 3, 2, and 1. Then, using the T-square, transfer from sheer-plan to half-breadth plan the points where the buttock-line is crossed by water-lines 2, 3, 4, and 5, and draw in the water-lines one by one with the batten and weights. Water-line 5 can be drawn forward with the batten from 1½ section, the part aft that section being then drawn by the aid of the French curves. To do this, square down from sheer-plan to half-breadth plan the extremity of the water-line on the overhanging part of the stern, also the intersection with the buttock-line, and draw a line to pass through these spots and to meet the line left unfinished by the batten. All the other water-lines may be drawn by the batten and weights alone, the long batten being used if possible. If, however, this is found too difficult, use the short batten, the after-part of each line to a little forward of midships being drawn first, and the fore-part from midship to stem added by turning the batten end for end. Use slips to check the half-breadths on water-lines at each section, and correct them if necessary. Apply the slips to the body-plan, set off the corrected half-breadths on each water-line, and, with the French curves, draw lightly the shape of each section to pass neatly through the corrected spots and those on the buttock-line. Lines 1 and 1½ will be the most difficult to draw correctly. Repeated alterations may be necessary, and it must be remembered that any alteration in the form of one vertical section will affect more than one water-line.

To check what has been done, set off another buttock-line on body-plan and half-breadth plan 2½ in. from centre, the after end of which will finish on the knuckle-line at a point directly below that on the deck. Square up from half-breadth plan to sheer-plan the points where it terminates on deck-line, and, lifting with a slip the heights above base-line at the various sections, transfer them to the sheer-plan, and draw the line with batten and weights as before. The batten will meet all the points if the previous work has been true. If the shape of a vertical cross-section at any other position than those given is required, square a line across the half-breadth plan at that particular place, lift on a slip the half-breadths of the water-lines and deck-line there, transfer them to the body-plan, and the points for the desired line will be thus obtained. The rudder outline may be either copied exact or modified, after which the work of inking and finishing the plan will alone remain. Black, red, and blue inks should be used. On the sheer-

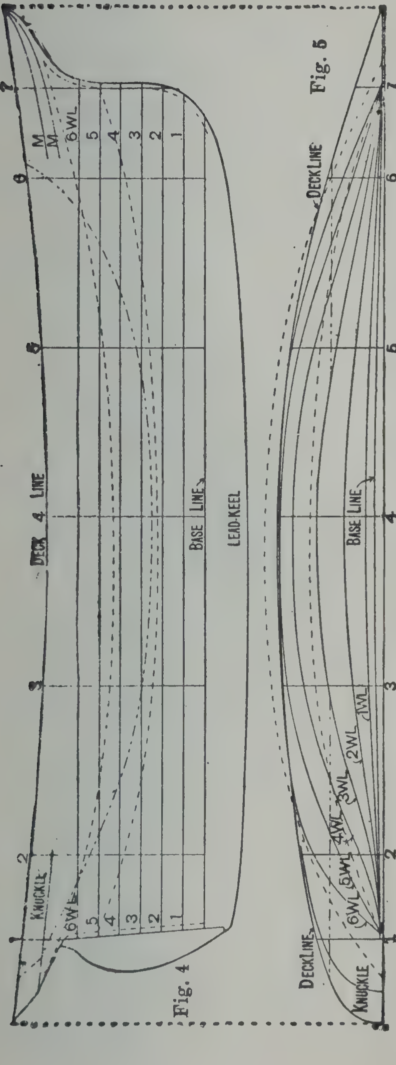


Fig. 4.—Sheer plan of Schooner; Fig. 5.—Half-breadth Plan of Schooner.

plan the deck-line, knuckle, stem, stern, rudder, base-line, and lead keel should be black; the vertical sections and buttock-lines red; the horizontal water-lines blue. On the body-plan the centre-line, buttock-lines, side- and base-lines should be red; water-lines blue; and the remainder black. On the half-breadth plan the deck-line, knuckle, and base-line should be black; centre-line, buttock-line, and cross-sections red; water-lines blue; perpendiculars A and B should be red.

The schooner shown by Figs. 4, 5 and 6 corresponds in the main with the cutter shown by Figs. 1, 2, and 3. The extreme length of hull is 48 in.; extreme beam, 10 in.; and midship depth without the lead keel, 7½ in.

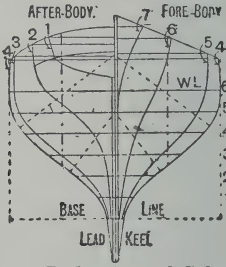


Fig. 6.—Body-plan of Schooner.

In constructing the hull there are at least five different methods from which a choice may be made: (1) the solid block model; (2) the system of using horizontal boards to represent water-lines, called the "bread-and-butter" method; (3) the system by which wood planks overlap one another; (4) tin-built hulls; (5) paper hulls. The solid block model has, however, been found to be the most suitable. The wood used may be either yellow pine, white fir, or other soft, straight-grained material, perfectly sound and dry.

The minimum dimensions for a solid block cutter will be 2 ft. 9 in. long, 8½ in. broad, and 7¼ in. deep, and, in dressing, the upper side may be left rough. Divide the length on the bottom, and mark off 1 ft. 4 in. each way; the marks so made will correspond with perpendiculars A and B on plan, Figs. 1 and 2, and leave ½ in. margin at each end. The intermediate sections may then be set off, and, with the 12-in. square, lines drawn right across at each mark, and continued up each side as seen in Fig. 7. Having set up the deck height on each, draw the deck-line through the points on each side, and cut out the sheer. After roughing it out, plane down to the line at each side, glasspaper it well, and square the sections and perpendiculars across it, making the centre-line full length by bending a straightedge into the hollow. Draw the deck-line, and mark the elevation of stern on each side of the block. The curved base-line may then be drawn from Nos. 1 to 7, the log being bottom upwards, in which position the waste wood abaft stern-post may also be sawn out. Draw the centre-line up both ends, and show the thickness of stem and stern-posts. The horizontal water-lines may, for convenience, be drawn on each side, and holes bored into the block where these intersect the vertical lines, the depth of each hole being ascertained from the body-plan; after this the sides of the block can be dressed down to the midship breadth. This may be accomplished by tracing sections from base-line to deck (as shown by 2, 4, 6), each section being subsequently pricked through the tracing paper on to the block. The proper mould for the hull may be thus obtained, moulds for the stem and stern being similarly cut. A convenient method of

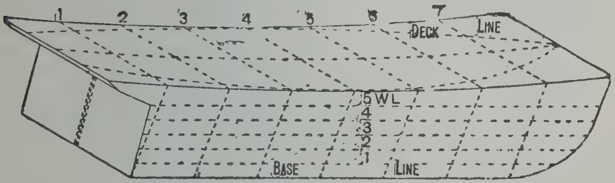


Fig. 7.—Block for Model Cutter.

holding the block for cutting and chiselling will be to fix two uprights about 3 ft. long to the front of bench, to which the block may be screwed, the screws being inserted horizontally into the deck of the model. Having sawn off each corner at the fore end, pare away the deck-line with an inch chisel, working from the centre to each end. Before commencing to cut, the line should be chalked, and great care must be taken so as not to chisel off the stem forward. Then with a large flat gouge little chips may safely be taken off at a time, the moulds being frequently applied to test the shape. When the large gouge has done its work, use an inch hollow gouge, then a small flat one, and finish with a small plane. One side of the hull should be finished first, and, if too much is taken off at any one place, the other side must be cut accordingly.

When the keel, stem, and stern have been neatly finished, the boat must be freshly propped in order that the inside may be hollowed out. The block in its new position may be held secure by fitting a chock to the midship form of the hull, and resting one end against the back of the bench whilst scooping out the other, thick padding being used to prevent the hull getting scratched.

The inside is gouged out so as to leave an even thickness of ¼ in.; the centre of the bottom may, however, be left thicker; a good plan will be to bore two or three holes into the block with a brace and bit to facilitate the scooping. In order to ascertain how much more requires to be taken out at the bottom, hold the boat up to the light frequently. The sides can, of course, be gauged by feeling with the fingers If a hole is accidentally cut through the hull, bore a larger one with the brace and bit, and insert a slightly tapering plug to fit it, smearing it with white lead before driving it tightly in. If the hole is the result of a long slanting cut, melt some elastic glue on a tin plate, and apply it thick, inside the hull, all along the thin part and over the hole; or, if preferred, apply a putty made of 1 part red lead, 1 part white lead, worked to a paste with copal varnish. In either case, a strip of calico about 2 in. wide should be glued inside over the crack, and rubbed over with elastic glue. When sufficient hollowing out has been done, sandpaper the outside, and give it two coats of spirit varnish, the inside being subsequently similarly treated.

If, instead of a solid-block model, it is desired to build one composed of six horizontal boards (Fig. 8), five yellow pine boards will be required, each 1 in. thick and another 2 in. thick, the latter to be the sheer-piece. For convenience of reference, the boards are numbered from the lowest upwards. The sheer-piece and Nos. 5 and 4 should be a trifle wider than the finished width of the boat; Nos. 3, 2, 1, respectively, should be 7 in., 4½ in., and 2 in. wide, the sizes given being for dressed material. The length of the sheer-piece should be 2 ft. 9 in., and of the other pieces 2 ft. 5 in. On the bottom of the sheer-piece mark off the centre-line, square up the fore end. and set off the sections from the plan, commencing at the fore end. After squaring these across and up both sides, mark on the deck heights, but measure above No. 5 water-line instead of the base. Obtain the height of the perpendicular by drawing No. 5 aft to it, mark the heights on both sides of sheer-piece, and bend the batten to the lines, the batten being held in position by stout needles. The centre-line may then be shown full length on each board, squared down the

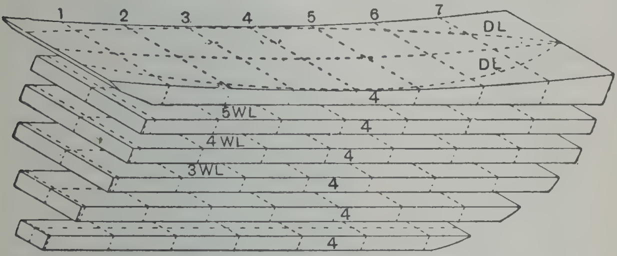


Fig. 8.—"Bread-and-butter" Method of Building Cutter Hull

ends, and drawn along the underside. Mark the cross sections on the upper side of each, measuring throughout from the fore end, which corresponds with the perpendicular on plan, and is cut square for the purpose. Set off, and draw with batten and weights the various water-lines. The cross-sections on No. 1 board must be squared round to the underside and the curved base-line shown there; after which, cut the sheer-piece to these lines, plane it true, and mark the deck-line on top. Saw away the waste wood of each board outside the line; but, instead of following it throughout its entire length, leave a breadth of 2 in. at the ends to secure good glued joints at stem and stern.

The spare wood at the fore ends of Nos. 1, 2, and 3 must be left on until the model is glued up. By puncturing the wood with a lead pencil, the shape of the water-lines in the way of the solid part may be followed with ease in cutting out. The lowest board, which is only 1¼ in. wide amidships, should be left its full breadth throughout, the shape of the upper line being pricked out from end to end. The interior of Nos. 2, 3, 4, and 5 must next be sawn out; to do this, lay No. 5 bottom upwards on the bench, and No. 4 on top of it, also bottom up, the fore ends being kept exactly together, the centre-lines to correspond aft. Transfer the shape of the upper to the lower by marking round with a pencil, remove No. 4, and roughly pencil another line ½ in. inside the first. Saw out to the inner line, leaving the extreme ends solid for screwing together. In the same way mark and cut out No. 4 from No. 3, No. 3 from No. 2, No. 2 from No. 1, but the latter has not to be cut at all. Lay the sheer-piece upside down on the bench, with No. 5 on top of it, and screw the two firmly together, the screws to be inserted close inside the stem and stern-posts. In like manner screw all the boards together for trial, then unscrew them and fasten together with marine glue, made by dissolving 1 part pure rubber in 12 parts naphtha and adding 20 parts powdered shellac. After fixing the sheer-piece firmly to the bench, apply the glue briskly with a large brush, rub board No. 5 backwards and forwards a few times to force the glue out from between the boards, and screw up one end quickly, the other being screwed simultaneously by an assistant, whose services have here to be brought into requisition. All the boards must be similarly glued. A slight tap with a hammer will overcome any displacement, if, just after glueing together, any are found out of truth. The craft must be laid aside in a dry place overnight before the work of hollowing out is commenced, during which care must be taken to avoid the screws at the ends. Much cutting will not, however, be required, as the greater part of the interior has already been removed.

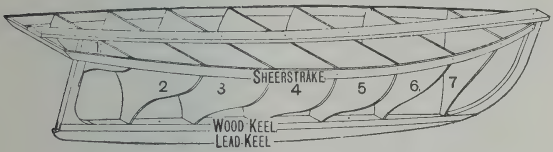


Fig. 9.—Wood-built Model.

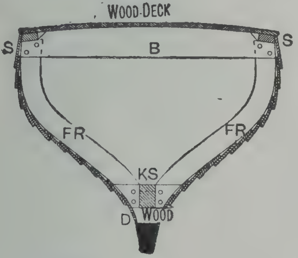


Fig. 10.—Section of Wood-built Model.

To make a wood-built model according to Figs. 9 and 10, procure a piece of hard wood for the wood keel, 2 ft. 3 in. long, $1\frac{1}{4}$ in. wide, and $\frac{1}{2}$ in. thick; plane it true and square, and draw a centre-line down each of the broad sides. Mark a point (No. 4) midway between the ends, and set off the other divisions on each side, omitting No. 1½. Draw the curved base-line on the underside, and a similar line on top, the half-breadths of the upper line being taken from the body-plan ½ in. above base, the distance it extends before No. 7 being ascertained by showing the same water-line in elevation on the sheer-plan. Shape the piece to the lines shown on top and bottom, and prepare the stem and stern-post, both of which should also be of hard wood. Dress a piece of board to ¼ in. thickness, and mark on it the outline of stem from sheer-draught, making it ½ in. wide throughout, the foot of stem being extended aft to about No. 7 section. The stern-post, ½ in. wide and ¼ in. thick, should be cut to form a knee at foot, as shown by Fig. 9. Both posts must be rabbeted to receive the plank ends (Figs. 11 and 12), and the rabbet continued to the lower side of wood keel. If desired, this may also be rabbeted (Fig. 13), but as a lead keel is to be fitted, the planking may be extended to meet it. The stem and stern-post may either be mortised into the keel or made to overlap it flush.

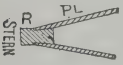


Fig. 11.

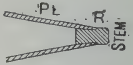


Fig. 12.

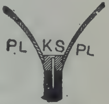


Fig. 13.

Figs. 11 and 12.—Posts rabbeted to receive Planks ; Fig. 13.—Method of Fixing Keelson.

It is now necessary to construct a diminutive shipyard, for which purpose a board 3 ft. long, 6 in. wide, and at least ½ in. thick, will be required. Stand it on edge, and fit strong brackets or chocks at each end to steady it on the bench. Fasten the wood keel, with stem and stern-post in position, to the upper edge, using 1¼-in. screws, one being inserted 1 in. abaft No. 2 section, another before No. 3, a third 1 in. abaft No. 5, and a fourth the same distance before No. 6. The building sections, which should next be cut out, should be of yellow pine ¾ in. broad and ⅛ in. thick, shaped from plan and connected by cross-pieces at top and bottom. The upper cross-piece or beam (B, Fig. 10) is rounded up about $\frac{1}{4}$ in. in the centre for the midship section, and on the others slightly less. At the ends of these cross-pieces, as also at the top of each frame F R, cut away to admit the stringer S $\frac{1}{2}$ in. by $\frac{1}{4}$ in., to which the deck is subsequently screwed. The cross-pieces at the bottom of No. 2, 4, and 6 sections are $\frac{3}{4}$ in. deep and $\frac{1}{4}$ in. thick, with a shallow notch cut in the upper edge $\frac{1}{2}$ in. wide and $\frac{1}{4}$ in. deep, over which the keelson or inner keel K S is afterwards fitted.

The sections are shown solid in Fig. 9, but framed sections are lighter—Nos. 1, 2, 4, and 6 will be sufficient The heel of No. 1 should be slightly lengthened, and rest in a notch on stern-post ; the others, which should be made to stand on the $\frac{1}{2}$-in. wood keel, should be fixed with fine nails. Tack to the centre of each, and to the stem and stern-post, a strip of $\frac{1}{4}$ in. wood W, allowing it to project a few inches abaft to support the stern.

Cedar, pine, pear-tree, or other tough wood will be most suitable for the planking, which should be cut into long strips $\frac{3}{4}$ in. wide, and not less than $\frac{1}{16}$ in. thick when planed up. Begin at the keel, work upwards at each side alternately, and fit cardboard strips to the hull as the planking proceeds ; from these, shape the planks, which should be steamed, if necessary, before fixing, so as to bend more easily. The top outer edge and bottom inner edge of each plank should be slightly bevelled to make a better connection, and white paint applied to the joint before closing. Copper nails are used throughout, holes being bored to prevent splitting ; the nails, of course, are neatly clinched inside the hull. When so much of the planking has been done that the after end of a plank lands on No. 1 section, prepare the stern and secure it by temporary sheer strakes fitted close to the deck, as seen in Fig. 9, and projecting the proper distance abaft No. 1 section on sheer-plan. The stern should be of hard wood, $\frac{1}{4}$ in. thick and $1\frac{3}{4}$ in. wide ; the lower edge will be

4½ in. long, the upper 4 in., a ⅝-in. chamfer being made along the former, a ⅜-in. on the opposite upper edge. Fit it between the sheer strakes with a couple of tacks, and continue the planking, fastening the after ends of each subsequent plank to the lower edge of the stern. When the deck is reached, strip off the temporary sheer strakes, and replace them by the topmost planks or sheer strakes proper, which should be ⅛ in. thicker than the other planks. Fill in all joints, inside and out, with white paint, and glue in small corner pieces of wood to connect the mould sections to planking; after which the complete hull may be thoroughly varnished, inside and out. Then get ready the keelson K S (Fig. 10), which should be 16½ in. long, ¾ in. deep, and ½ in. thick. Notch the underside to clear No. 4 section; the ends should form ledges which rest on the lower part of Nos. 2 and 6. Fasten the keelson to the wood keel with four brass 1 in. screws, one being placed 1 in. in from each end, the others 2⅜ in. before and abaft the midship section.

In the case of the tin-built model (Fig. 14), the lead keel is cast first, and to this the stem and stern-post, which may be of brass ⅜ in. by ⅛ in., are soldered. Erect solid building sections, fit temporary sheer strakes at sides in addition to that along the centre, and commence plating from the keel by fitting the cardboard templates full length and as wide as convenient, allowing the bottom strake to overlap the keel about ¼ in. throughout its length. Laps L are first arranged on plan, and the building sections marked accordingly. The topmost strake should stand ¼ in. above the height of deck to form a low bulwark G fore and aft, thus permitting the soldering or riveting of deck to hull, the deck being also of tin, flanged all round to form a tray. Remove the wood building frames before decking, and solder in tin ones of the shape shown in Fig. 14.

The "shell" of the model yacht having been completed, it must be sufficiently heavy below water to ensure its good behaviour when under sail. For this purpose a lead keel will have to be made and fixed, an iron one being much too bulky. The proper weight of the keel may be roughly ascertained by placing the hull on the water and loading it till the right displacement is reached.

The displacement is the total weight of the boat, measured by the equivalent weight of water in cubic feet. The average weight of fresh water is 62·5 lb. per cubic foot; salt water is from 2 lb. to 2½ lb. heavier per cubic foot. For example, a boat weighing 1 ton with all fittings complete would displace 35·8 cubic feet in fresh water, while in salt water the displacement would be only 34·7 cubic feet. If the rectangular figure formed by the length at load water line multiplied by beam at load water line multiplied by depth from load water line to base line contains 92 cubic feet, the boat's displacement, or solid contents below load water line, will be about 35 cubic feet; and the ratio that these solids bear to each other is called the coefficient of displacement, which is ·38 in the case mentioned. This fraction varies, being about ·30 in ordinary boats and about ·45 in yachts.

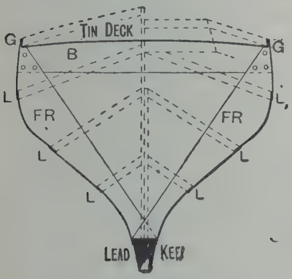


Fig. 14.

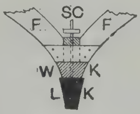


Fig. 15.

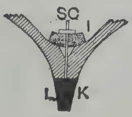


Fig. 16.

Fig. 14.—Section of Tin-built Model; Figs. 15 and 16.—Attaching Keel to Solid Model.

A mould in which to cast the lead keel can be made by fixing two thin pieces of wood, 25 in. long, to the sides of a ¼-in. piece of the same length, taking care to make them perfectly tight. Make the side-pieces broad enough to give a clear inside depth of 1¼ in. at one end and 1 in. at the other, and stop the ends with wood. Fix a short cross-piece between the upper edges of the side-pieces to hold them about ⅞ in. apart, so as to make the top of keel correspond with the curved base-line on plan. When the lead has been melted in a proper vessel, skim it with an iron spoon, for if dross gets into the mould the keel will be porous. Fix the mould firmly on bench or floor, elevate the shallow end to bring the upper edges of side-pieces about level, and pour in the lead steadily until the mould is almost full. When cool, plane the upper edge true and make it to correspond with its place on the hull; the sides may also be planed if they are not sufficiently smooth. Cut away the lower edge to the shape shown in Fig. 13, and tie pieces of string, 18 in. or 20 in. long, round the lead at a few inches from each end. Mark on each end of the model the draught or water-line, 2¾ in. below the deck at the stem and 4⅝ in. above the keel at stern-post. Fasten the keel temporarily to the hull by the strings and place the craft in water. If it floats all right, nothing further need be done; but, in all probability, the lead will need to be further cut; allowance must, however, be made for the subsequent addition of deck, masts, etc., which, in a cutter, will amount to ¼ in. at each end, but in a schooner-rigged craft it will be more. If further adjusting is needed, cut away the lower edge until the model floats with the draught-line at each end ¼ in. above water.

Bore, to a depth of ½ in., the holes for the two upright screws (sc, Fig. 15), one 6½ in. from aft end of keel, the other 12 in. from that. Use 2½ in. brass wire screws, threaded half their length on the upper end, each having a substantial nut which, if round, must be nicked to prevent the pliers slipping. Square ones will, however, do as well. Solder on at an inch from each end the clips shown at stem and stern (Fig. 17), also the vertical screws. The clips C L should be of strong sheet brass 1¼ in. by ⅜ in. Cut the ends round, drill a $\frac{1}{16}$ in.

hole through the end, and bend them with hammer and pliers, taking care in the bending that they are made exactly the width of the lead keel. Turn the boat bottom upwards, mark on the wood the places where the

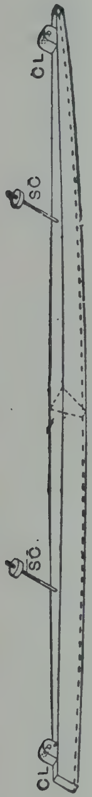


Fig. 17.

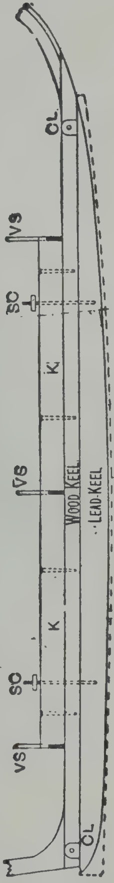


Fig. 18.

Figs. 17 and 18.—Method of attaching Keels to Wood-built Models.

screws should enter. Bore the holes with a bradawl exactly the size of screws, and countersink them with a small gouge. Apply white-lead along the keel and round about each screw, fit the model and keel together, and allow the screws to press out the waste lead. Screw down two indiarubber washers I (Fig. 16), which must fit the screws tightly, and add the brass nuts, thus fastening the keel as shown in section. Fit a copper rivet through the holes in each clip to secure the ends, trim off the extremities of the lead, and cut off the forefoot to make a fair line with stem, leaving the afterpart to project ¼ in. abaft the stern-post to support the heel of rudder. Tack a narrow strip of sheet brass along the bottom and well up the stem to preserve the keel from damage in beaching.

The lead keel may also be attached to the hull by ordinary brass screws about 1 in. long, fitted from without, and made to pass through the lead in a slightly diagonal direction into the hull. The screw-heads, thus recessed into the lead, are covered with putty; but, in the event of the lead working loose, difficulty will be experienced in tightening the screws. All screws, nails, etc., used in the construction of the model should be of brass or copper. No iron should be used, as it rusts and rots the wood, as well as disfigures the paint. Figs. 17 and 18 illustrate a suitable method of attaching keels to wood-built boats, the processes above described having more particular reference to solid-block and "bread-and-butter" models. In Fig. 18, the vertical sections are shown at V S, over which the keelson K is fitted and secured by screws to the wood keel; mahogany or teak will be suitable for this latter. The vertical screws S C of the lead keel pass through keel and keelson, they and the end clips being fitted as previously explained.

Give the boat a good coat of varnish inside and out, allow a couple of days for it to dry and for the keel to set, after which the fitting of the deck may be proceeded with. Ten inches abaft the stem fit a strong cross-beam (M, Fig. 19) 2 in. by ⅜ in. across the hull in the way of the mast;

its centre should be ⅛ in. higher than the sides, as shown in Fig. 19. Notch the gunwale to receive it, make the beam to lie flush, and, if the mast is to pass through the deck and step in the boat's bottom, bore a ⅝-in. hole in the beam before fitting. To stiffen the deck in the way of the bowsprit, fit a similar piece from beam to stem, letting these two neatly into each other; half-way between M and the stern another cross-beam will be required. Poplar is most suitable for the deck, but yellow pine will do. Let the timber selected have a clear straight grain, and the piece be 2 ft. 9 in. long, 8½ in. wide, and about ⅛ in. thick. Dress one side, pencil a centre line full length, set off ¼-in. spaces at each end to represent the deck seams, pencil these in, and show the centre-line on the underside also. Stand the model in a chock on the bench, apply the deck face downwards, and bend it into the sheer by means of a weight placed in the centre. Pencil round the deck-line, remove the deck, and cut away to within ½ in. of this line. Fit it again, right side up, weight it as before, bore a screw-hole ¾ in. abaft the stem-head, and another 1 in. in from stern at centre. Screw down at these places with ⅜-in. brass screws, and bore holes every 2 in. for the remaining screws along the bulwark. Unscrew the ends, apply white-lead along

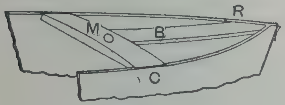


Fig. 19.

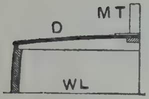


Fig. 20.

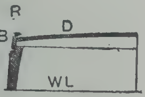


Fig. 21.

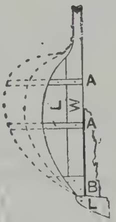


Fig. 22.

Fig. 19.—Adjustment of Cross-beam; Fig. 20.—Section of Deck, finished plain; Fig. 21.—Section of Deck fitted with Bulwarks; Fig. 22.—Elevation of Rudders.

bulwarks and cross-beams, and screw down again, beginning at midships and proceeding alternately to each end, using brass screws only, not longer than ⅜ in. Countersink and cover over the screw-heads. Dress off the projecting edges, if the edge of deck is to be made flush; or, if preferred, strike a moulding. It will be best not to fit any bulwarks, but whether or not one is fitted a margin plank must be painted round the deck ½ in. wide throughout. If a bulwark is desired, fasten slips of hard wood ⅛ in. on each side from stem to stern, small brass screws being used to secure them in position. In addition to the method shown by Fig. 20, the deck may also be fitted by sinking it ¼ in. or so below the bulwark B, which is reduced in thickness at that part and carries a hard-wood rail R (Fig. 21). Such an arrangement will, however, interfere with the boat's speed.

None but a free rudder controlled by weight will be serviceable to a sailing model. Either the rudder or the tiller may be weighted; if the latter, it must be fitted abaft the rudder head, and furnished with a screw thread. On this a weight is fitted to traverse fore and aft, thus being adjustable. The holes in hull and deck should be commenced with a long, straight, red-hot wire, which ensures the rudder-head at deck being in line with the stern-post, after which they can be cut to the required diameter, and a ¼-in. brass tubing neatly fitted in to form a watertight rudder-trunk. Fig. 22 shows an elevation of rudders required. They should be of hard wood ½ in. wide and not less than ⅛ in thick, bound with strips of sheet brass A and B. The brass pintle should be fitted into the heel of the rudder and made to work in the projecting end of the keel, a small brass washer being provided to reduce friction. If it is desired to dispense with the tiller above deck and leave the weighted rudder quite free, omit the trunk and fit the rudder-head with a vertical spindle similar to, but longer than, that at heel. The three rudders shown in the illustration are 1¼ in., 1⅞ in., and 2½ in. wide

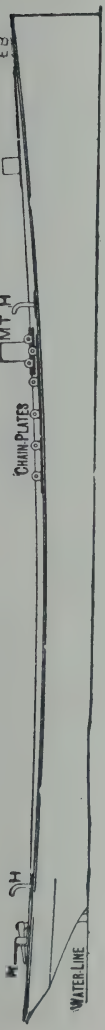


Fig. 23.

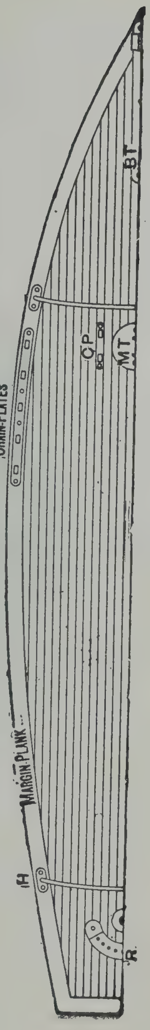


Fig. 24.

Figs. 23 and 24.—Deck-work for Cutter.

respectively, but make them larger at first and trim them down afterwards. The letters W and L indicate wood and lead respectively.

Another method of making a rudder is to construct a frame of rhomboid shape of three pieces of mahogany or teak; the frame is kept together by a sheet of thin copper folded over it and riveted with copper tacks passing through the frame and copper sheet. It thus forms a hollow box open at the back, into which suitable pieces of lead, varying in weight from 1 oz. to 1 lb., may be placed to weight the rudder as desired. Screw two screw-eyes on the rudder, and pintles of stout brass should be fixed in the stern-post for the screw-eyes to hook on to. A safety catch of sheet copper will prevent the rudder slipping off. It is pivoted to the stern-post, and may be moved to one side to allow a rudder to be shipped or unshipped.

As few as possible deck fittings should be introduced, because they hold an amount of wind which hinders the vessel's speed. In a cutter the only deck-work required consists of a mast tube (M T, Figs. 23 and 24), bowsprit tube, chain-plates, and horses. The mast tube, which is shown 1 in. high, may be made lower; its outside diameter is ⅝ in. It may be fixed by soldering it to a circular disc, 1½ in. in diameter, drilled to receive the screws by which it is screwed to the deck. To form the bowsprit tube B T, solder two ½-in. pieces of the same tubing horizontally to a brass deck-plate 5 in. by ½ in., leaving sufficient space to admit screws. A double eyelet of brass, marked E B (Fig. 23), soldered to the forepart of the bowsprit tube, takes the lower end of the forestay. The bowsprit may, if so desired, be made square in section where it lies on the deck. If so, take care that it slides freely through the tubes or bitts, which, of course, will also have to be square. In this instance they may conveniently be made of sheet copper and fastened to the deck by small brass screws. An indiarubber door-spring may be fastened to a screw-eye at the butt of the bowsprit, the loop or ring at the other end of it being attached to a screw firmly fitted through the deck into the hull. The bobstay, when taut, will keep the bowsprit in its place, and, in case of collision, or if the boat runs against a steep bank or wall, the spring will allow the bowsprit to slide back undamaged.

The two larger chain-plates, cut to correspond with the curve of the deck-line (Fig. 24), are also of brass, 5 in. by ¼ in., and are fitted on the margin plank. Each carries five eyelets soldered 1 in. apart, screw-holes being drilled as shown; in fixing, the foremost eyelet is placed exactly opposite the mast tube. The deck-plates C P, which are 1½ in. long by ¼ in. wide, and have two eyelets in each, may be placed 1 in. each side of the mast tube. The horses, marked H, are made of strong brass wire bent to a slight curve, the ends being turned down and screwed to the margin plank. They may have a clear space of ⅛ in. at centre of deck.

CHAPTER II.

RIGGING AND SAILING MODEL YACHTS.

THE construction of a model yacht having now been fully described, the rigging may be proceeded with, and as a commencement the mast and spars may be made. Fig. 25 illustrates a cutter fully rigged, drawn to a scale of ½ in. to a foot. Yellow or white pine will be the best wood for masts, gaffs, and booms ; lance, ash, or hickory is suitable for the bowsprit. Plane the wood in each case to a square form of the required diameter, dress off the corners to an octagon, and round with a small plane. If preferred, bamboo may be used for masts and spars.

The mast will require to be 34 in. from deck ; the bowsprit, 21½ in. ; boom, 23 in. ; gaff, 14½ in. ; gaff-topsail yard, 11 in. ; fore-staysail boom, 8½ in. ; and jibboom, 15½ in. The mast should be broadest at deck, the diameter there corresponding with the outside diameter of mast socket, the heel of mast being reduced where it enters the socket. At the hounds, 20 in. above deck, the diameter should be slightly less ; at the topmast-head, 12 in. above hounds, it may be made half the diameter at deck. The pole above topmast-head is tapered merely for appearance. Bore a hole in a fore-and-aft direction through the mast at hounds, and fit a brass pin, shaped as at H (Fig. 26), for carrying the bent ring to which the shrouds are attached. At the head (Fig. 25), 4 in. above the hounds, file a notch round the mast, and another at the topmast-head. A circular "truck" of hard wood makes a neat finish to the masthead. The bowsprit projects 16 in. beyond the stem, 5½ in. being inboard or on deck, the after part to slide freely through the bowsprit tube, the fore end to be reduced to ⅜ in. diameter. Fit a short hoop of brass tubing (H, Fig. 27) on the fore end of bowsprit, this hoop to have a double eyelet soldered on its upper edge, and a single one below, its purpose being to preserve the

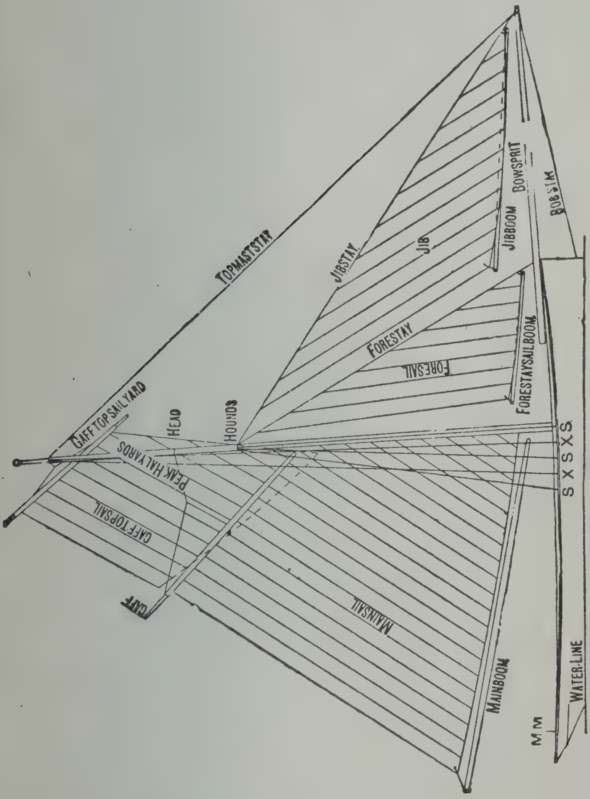


Fig. 25.—Cutter fully Rigged.

bowsprit from splitting. Bore a hole horizontally through the heel or aft end of bowsprit, and insert a strong brass pin to hold the spar in place. The main boom, 23 in. long by ½ in. diameter, is reduced to ⅜ in. aft and $\frac{5}{16}$ in. at fore end. Short hoops, similar to that on the bowsprit, may be fitted to the boom, in addition to which the outer end (Fig. 28) carries a projecting eyelet A. The inner end is fitted with a hook, which works freely in a small socket (on M T), or may be fitted with jaws, as shown in Fig. 29, secured by glue and thread lashing. The gaff (Fig. 25), $14\frac{1}{2}$ in. long by $\frac{3}{8}$ in. diameter, has the ends tapered to $\frac{1}{4}$ in., and notches filed round at 2 in. and 8 in. from the upper end. It may be fitted with jaws also, but a much neater arrangement is shown by Fig. 26, where the gaff is hooped at H to receive an eyebolt which

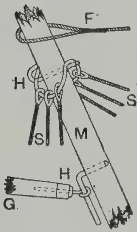


Fig. 26.

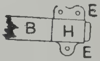


Fig. 27.

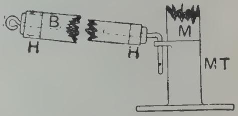


Fig. 28.

Fig. 26.—Method of attaching Shrouds; Fig. 27.—Brass Tubing for Bowsprit; Fig. 28.—Main Boom with Hoops.

works on the projecting guide, its position being regulated by an adjustable sling, or "throat halyard," from the hounds above. The gaff-topsail yard, 11 in. long by $\frac{1}{4}$ in. diameter, is notched at $1\frac{1}{2}$ in. from head and 1 in. from heel. The fore-staysail boom and jibboom are respectively $8\frac{1}{2}$ in. and $15\frac{1}{2}$ in. long by $\frac{1}{4}$ in. diameter. The ends of each may be slightly notched with the file for the sail lashings.

Step the mast in the deck socket and prepare the shrouds (S, Figs. 25 and 26). They are connected to the mast at hounds by a brass ring, 1 in. in diameter, bent as shown in Fig. 26, and resting on the fore-and-aft pin H. Let each of the six shrouds be 26 in. long, of strong cord, and their upper ends at hounds neatly lapped and bound round with thick black thread

(Fig. 26). Fit the lower ends as shown in Fig. 30, the device consisting of two S-shaped links E, the lower one of which hooks on at A to the chain-plate. Shroud B is passed through it, and the end forming loop C is attached to the upper link. Hold the shroud with one hand at B and the upper link with the other, and draw the hands together to tighten the shroud, which will remain tight. Fit the same connection to all rigging, including that from the topmast-head X, Fig. 25. But leave these topmast backstays and the topmast stay off for a while, and end fit the two lower stays. The forestay is formed into a loop at the upper end (F, Fig. 26), which is passed over the masthead and allowed to rest on a brass pin H. Fit the lower end with a strong brass hook, which attaches to the outer eye on bowsprit tube, and fit the bowsprit, securing it by inserting the brass pin. Fit the jibstay in a similar manner, its lower end being taken to the outer eye on the bowsprit.

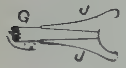


Fig. 29.

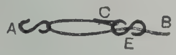


Fig. 30.

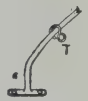


Fig. 31.

Fig. 29.—Jaws for Main Boom; Fig. 30.—Method of attaching Lower Ends of Shrouds; Fig. 31.—Horse and Traveller.

Fit a brass staple in stem near the water-line to take the inner end of bobstay, which must also be made adjustable, as in Fig. 30. The shrouds, forestay, jibstay, and bobstay should be of the same strong cord; the topmast rigging and all running rigging may be finer.

The slinging of the gaff may next be proceeded with, the principal parts of the standing rigging being now in place. The throat, or inner end, however fitted, may be suspended from the hounds by the short adjustable throat halyard (Fig. 30). The peak, or outer end of gaff, is set by a short bridle of cord, attached to the gaff as shown, and controlled by the peak halyard (Fig. 25), which is also an adaptation of Fig. 30, the lower eyelet working freely on the bridle, and the upper end fixed to the mast at head. Or, instead of making the peak halyards a short length between mast and gaff, a single halyard may be taken from the bridle, through a small pulley-block or eyelet on the mast, and the lower end attached to one of the small deck-plates. The short peak halyard is, however, preferable.

Sling the main boom in position by fitting a temporary "topping lift" from the hounds to outer end of boom to hold the boom in position until a paper pattern of the sail is obtained. Top the outer end of boom well up, so as to prevent the foot of the sail dragging in the water when the boat heels over; this remark applies also to all lower sails. The traveller (Fig. 31) must move freely on the horse. The mainsheet is a cord having one end attached to the traveller, the other passing through a block or eyelet on the boom and led forward. The length of the sheet, and with it the sideboard play of the sail, may be regulated by boring a number of holes not less than ¾ in. apart through the boom, and providing the inner end of the sheet with a pin which is inserted in one or other of the holes, leaving more or less of the sheet at liberty. It may also be regulated by arranging the inner end of the sheet as in Fig. 30, and attaching it to an eye in the boom, or on deck.

The gaff-topsail yard is slung by a bridle similar to the gaff. Instead of sliding freely upon the bridle, this halyard must be fixed to it, and led through a pulley-block at topmast head, then attached to chain-plate on deck. Sew the gaff to a brass ring, which must slide easily on the mast.

Everything in connection with the model yacht is now complete with the exception of the sails, paper patterns of which should now be cut out. The after leech (or edge) of every sail is quite straight, but the foot (or lower edge) is curved. The heads of mainsail and gaff-topsail are straight where attached to the gaff. The luff of mainsail lies close against the mast, to which it will be secured by rings; the luff of the gaff-topsail is cut to stand slightly before the mast at the head, the tack extending 1 in. or so below the gaff, as shown by dotted lines. This sail is not attached to the mast, but hangs freely by the halyard. Make the gaff-topsail and balloon jib of muslin, the other sails of best linen. Unless the cloth is well stretched before being cut, the sails will soon lose their shape. It should first be dipped in boiling water and rinsed in cold water, then tacked out on to a board.

When cutting out, fix the patterns with the after leech of each sail exactly on the selvedge of the cloth, but leave at least ¼ in. round the remaining edges for hemming. Down each of the sails run single brown threads 1 in. apart, parallel to the leech Sailcloth having the lines already printed may, however, be purchased at from 10d. to 1s. per yard, double width. Sew a small loop of tape in the corners of foresail and jib, and in the lower corners only of mainsail and gaff-topsail. Sew the head of the latter to the yard, but secure the mainsail to the gaff by small brass rings not more than 1 in. apart. Sew seven brass rings ⅜ in. diameter to the luff of mainsail, at distances of 2 in.; bore a small hole in the mast immediately above the lowest ring, and fit a brass pin for the tack; this pin and a short earing at the boom end will keep the clew in position. The staysail boom and jibboom may be sewn full length to the foresail and jib, or merely at the ends as shown. These sails slide on the stays by small brass rings, 1¼ in. apart, the lower corner being secured by a short cord to the eyelet on bowsprit. From the topmost ring on each stay lead a cord over a small pulley or eyelet at the hounds, thence to the deck, fitting a long adjustment similar to Fig. 30, which admits of lowering the sail on the stay. A light cord attached to the lower corner of gaff-topsail is led down to the small deck-plate, and the outer edges set as shown. The fore and main sheets work on horses, but the jib sheet must pass through an eyelet on fore end of bowsprit tube, then be led either inboard or along the outer part of the bowsprit, and made adjustable as before. The bowsprit may be further strengthened by fitting shrouds from the outer end to eyelets on the boat's side, a little before the mast. Lastly, fit the topmast stay and backstays. There should be no bagginess about the sails, which should set as flat as possible. This is an important matter, especially when sailing to windward. Bag in the leech of a sail is a drag on the boat's forward movement, and decreases the speed. Sail can be reduced by reefing, but it is neater to replace

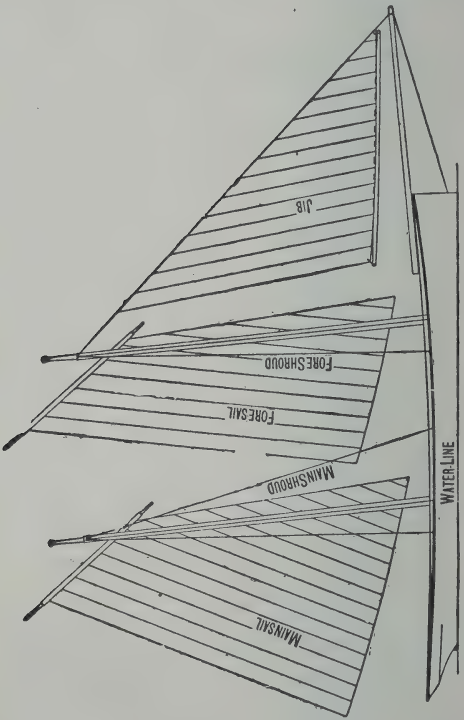


Fig 32.—Alternative Method of Rigging Cutter.

a large sail by a smaller one, and there is then less weight of wet cloth to carry.

Instead of fitting up the cutter hull as described, it may be fitted as Fig. 32, the illustration being on a scale of ½ in. to the foot. The masts, spaced 8 in. and 19½ in. abaft stem, are each 24 in. extreme length from deck, 2 in. being allowed for pole. The diameter at deck is ½ in. Bowsprit, 17 in. extreme length; housing on deck, 5 in.; diameter, ½ in. at heel or inner end. Fore gaff, 12 in. long by ¼ in. diameter. Main gaff, 11 in. by ¼ in. diameter. Jibboom, 15 in. by ⅜ in. diameter. Booms are seldom fitted to this style of sail, but the mainsail will stand better with a boom 15 in. by ½ in. Two shrouds are fitted to each mast, spaced 2 in. apart on deck. The mainstay is double, but need not be detachable. Sling the gaffs by bridles and halyards, and sew to a brass ring which moves freely on the mast.

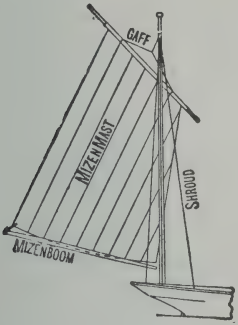


Fig. 33.—Mizzen Mast and Sail.

Fig. 25 may be converted into a yawl by adding a short mizzen mast and sail (Fig. 33), the position of which (indicated by M M, Fig. 25) necessitates a narrower mainsail, the boom of which must clear the mizzen rigging. The extreme length of mizzen mast is 17 in., allowing 1½ in. pole; the diameter at deck need not exceed ⅜ in. The extreme length of gaff is 10 in.; its diameter ¼ in.; boom, 10 in. long by ⅜ in. diameter. The sail is a lug, the yard extending a short distance before the mast, similar to the gaff

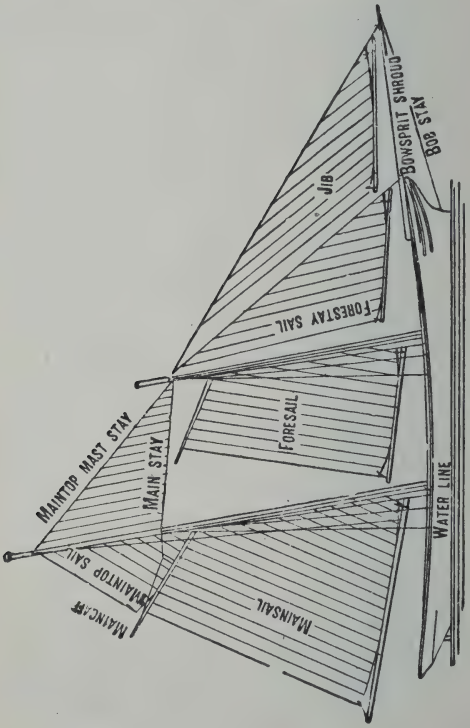


Fig. 34.—Method of Rigging Schooner.

topsail in Fig. 25; or it can be made similar to a mainsail, with rings to slide on the mast. By this means the only objectionable feature in a yawl rig will be overcome. Fit two shrouds at each side, and a double stay, the latter led to the deck about 2 in. before the mast. As the mizzen mast is placed so far off, leaving no room for the usual horse and traveller, fix a spar on deck, projecting about 4 in. beyond the stern, and carrying at its outer end an eyelet through which the sheet is led inboard and regulated by the device shown by Fig. 30. Or the outer end of the sheet may be fixed to the boom at about half its length and the inner end attached to the deck-plate in the centre making it adjustable as before.

Fig. 34 shows the method of rigging a schooner, the scale being ½ in. to a foot. Two masts are shown, fore and main, 15½ in. and 29½ in. abaft stem, from which the various spars, sails, stays, etc., are named. The sails are: Mainsail, foresail, fore-staysail, jib, fore and main gaff-topsails, and fore-topmast, staysail or flying jib (not shown). Schooners usually carry jib-headed gaff-topsails, which have no gaff or yard, but slide on the mast by hoops or rings (similar to the trysails), the head of the sail being hoisted by the usual halyard worked from the deck. The dimensions of masts and spars are: Foremast, extreme length, 39 in.; deck to hounds, 24 in.; hounds to head (topmast), 12 in.; pole, 3 in.; diameter at deck, ⅝ in.; hounds, ½ in. full; topmast-head, ⅜ in. Mainmast, extreme length, 40½ in.; deck to hounds, 25½ in.; hounds to head, 12 in.; pole, 3 in.; diameters, same as foremast. Bowsprit, 22½ in. extreme length; housing (part on deck), 6 in.; diameter at heel, ½ in.; forward, ⅜ in. Fore gaff, 9½ in. extreme; peak, 2 in.; diameter, ⅜ in. Main gaff, 12 in. extreme, peak, 2¼ in.; diameter, ⅜ in. Fore boom, 13 in. long by ½ in. diameter. Main boom, 22 in. long by ⅝ in. diameter. Fore-staysail boom, 12½ in. long by ⅜ in. diameter. Jibboom, 14½ in. by ⅜ in.

The mast sockets and bowsprit tube resemble those of the cutter, but are of larger diameter; the chain-plates and horses are the same. Fit a permanent main-topmast stay as shown, but let the mainstay lead to the foremast head, the forestay being made a little stronger to support both masts. The foresail will then work without fouling. The bowsprit shrouds may be led 6 in. or 7 in. abaft the stem.

In Fig. 35 is illustrated a type of schooner in which the topmasts and gaff-topsails are dispensed with.

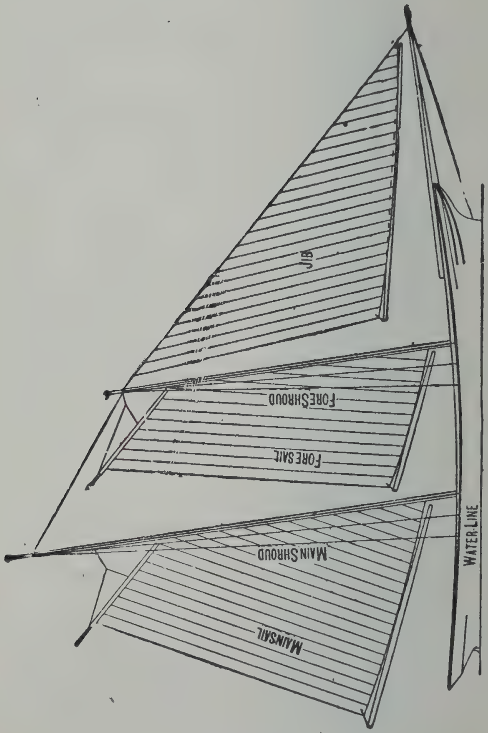


Fig. 35.—Alternative Method of Rigging Schooner.

This style of vessel is by far the best of its class. A jib only is shown, but, if necessary, it may be divided into fore-staysail and jib. The dimensions are: Foremast, extreme length, 33 in. from deck, 1¼ in. pole; diameter at deck, ⅝ in.; at head, ⅜ in.

Mainmast, extreme length, 43 in. from deck, 2 in. pole; diameter, same as foremast. Bowsprit, 25½ in. extreme length, 9 in. inboard; diameter at heel, ½ in. Gaffs, each, 12½ in. extreme length; ⅜ in. diameter. Fore boom, 14 in. long by ½ in. diameter. Main boom, 22 in. by ⅝ in. diameter. Jibboom, 27 in. long by ⅜ in. Masts are spaced 15 in. and 29½ in. abaft stem; there are six shrouds to each mast, spaced 2 in. apart.

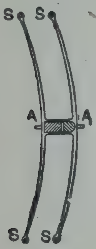


Fig. 36.

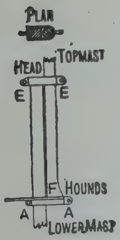


Fig. 37.

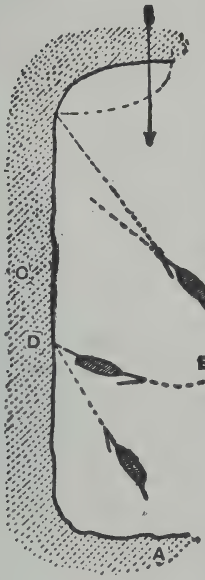


Fig. 38.

Figs. 36 and 37.—Method of Doubling Fidded Mast; Fig. 38.—Diagram illustrating use of the Guy.

In some instances it may be desirable to fit "fidded" topmasts, although pole masts must always take precedence in a sailing model. Figs. 36 and 37 (scale, 1 in. to the foot) show a method of doubling such a mast for a cutter. The upper part of lower mast, from hounds to head, is cut nearly square. A light crosstree of brass (Fig. 36) is fitted at the hounds, in the forepart of which slides the topmast. The projecting arms take the topmast rigging, the necessary eyelets for shrouds, forestay, etc., being provided. The upper cap is a similar hoop, but without other projections than the eyelets shown. Fit a brass fid F through the heel of topmast to hold the topmast in position, the same being supported by the crosstree.

Nothing except varnish has so far been applied to the boat, so the hull may now be painted with a preparatory coat of any colour. This done, draw a level line along each side at 1½ in. below the deck amidships. To do this, prop the boat upright on any smooth surface, and set a block of wood (dressed on its underside, and carrying a metal marking point) to correspond with the 1½-in. mark on the boat's sides. Try it at stem and stern, and carefully gauge it along each side, thus scratching a steady, continuous line. All above the line may then be painted whatever colour be chosen; all below the line copper colour. The masts, spars, etc., will only need to be varnished.

If the boat is to be painted white, proceed as follows:—After the model has been thoroughly sandpapered down, give it one coat of paint, made by mixing ordinary white French polish with flake white powder until it has the consistency of skimmed milk. When this first coat has dried quite hard, rub it down with No. 0 sandpaper; dust the model and give it another coat of the same paint; repeat this process at least six times. Then give it another coat, but, instead of smoothing it with sandpaper, rub it down with powdered emery and water, using a piece of hair-felt. Repeat this, and a beautiful white will be the result. This should not be varnished.

A mahogany or walnut-stained and French-polished hull looks very well, and is very smooth; it should, however, receive one or two coats of the best copal varnish, finishing off by rubbing down with powdered pumice-stone and water.

A good boat may be made to sail in any direction up to within an angle of 45° (or 4 points) of the wind, the sails requiring to be differently trimmed for each course, according to the angle the direction of the wind makes with the desired course.

Fig. 38 shows the use of the guy. Say it is required to sail the yacht from A to B, keeping her on the side C of the pond. On starting she heads for D, her boom having been previously guyed on the port (left) side. On arriving at D she is turned out again, and takes the course shown in the dotted line, going about at E, when she resumes her original tack. The mainsail being guyed compels her to go about.

If the jib is too big and too powerful for the mainsail, a model will not "stay," or will be very slow about it. It will be the same if the rudder is too heavy. Speed depends quite as much on the proper cut, setting, and trimming of sails as on the excellence of the model. An inferior model well sailed will frequently outsail a good one which has badly-fitting sails or is not well handled. The sails should set as flat as a board, if possible. Flatness is everything in going well to windward, a capability which should be possessed by every model craft.

If a boat shows a disposition to "fall off" or turn away from the wind, lighten her rudder or take it off. If she is still at fault, replace the jib by a smaller one, and haul in the mainsheet a trifle. The exact length of sheets or trimming can only be found by practice. Some boats cannot carry much head sail, on account of their keels not being deep enough forward.

If a boat will "run up" into the wind, ease her main sheet. If she continues to do so, tauten her jib sheet; and, as a last resource, put on a little heavier rudder. A small piece cut off the forefoot or forward end of the keel may cure a boat of a tendency to run up to the wind. If, however, the mast is stepped in the proper place, these remedies are not required.

Boats with too sharp bows or with bows not high enough out of the water are apt to bury themselves when running fast before the wind. In this case the sail must be reduced. A boat that buries her bows generally requires a little more weight on her keel aft. Lead may be added by soldering a piece on, or molten lead may be run into holes made in the wooden keel, thin pieces of wood being temporarily tacked on. The mast rake will also prevent this fault to a great extent.

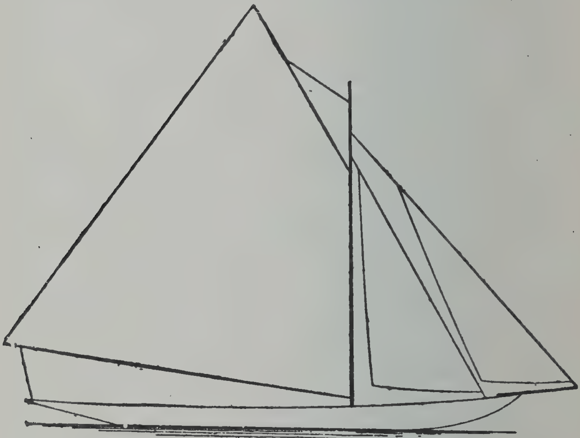


Fig. 39.—Sail-plan of Yacht for Reaching.

If a boat makes leeway, or drifts sideways, she is carrying too much sail, in which case the sail should be reduced; or her keel is not deep enough.

A boat should not be overpressed with sail. If the lee gunwale is below the water, the boat will not sail so fast as she will when more upright, even though she carries less sail. A boat with too much sail in a strong wind drifts away to leeward, and does not keep her course.

If a smaller mainsail is set, or the mainsail is reefed, a correspondingly small jib should be set. A large jib with a small mainsail will, if the boat is properly constructed, make her run off the wind. For going to windward the headsail should not be too large.

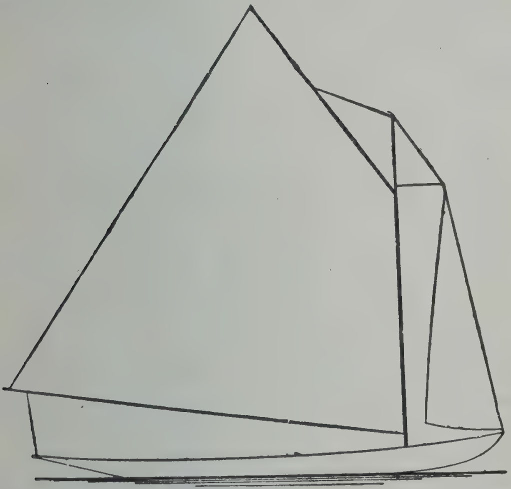


Fig. 40.—Semi-cat Yacht Rig for Beating and Running.

At the end of every course, the boat should be taken out and any water that may have leaked in should be emptied out. A boat that keeps her course by proper proportion of sail fore and aft will sail much faster than one which needs helm pressure. Jibs and other head sails prevent burying when running free with wind abaft the beam, though, obviously, they are of little use with wind dead aft.

Do not "tie down" a boat, but slack out the sheets as much as the direction of the wind will admit. Do not roll up the sails until they are thoroughly dry.

The following notes have their especial application in the designing and rigging of model yachts intended chiefly for racing. The first thing to be considered when designing a racing model yacht is whether the usual course to be raced over is a beating, reaching, or running one, or any combination of these. If the course is all reaching, a long water line, narrow beam, and light displacement boat would probably pay best if suitably rigged with mainsail, foresail, and jib, as shown in Fig. 39. But a course which generally consists of a beat to windward and a run home requires a boat of quite another type—one with a shorter water line (L. & S. A. rule) and more sail area, considerably more beam, and also heavier displacement. To get the best results this boat should be rigged as shown in Fig. 40, with most of the area in the mainsail, so as to get the full benefit of the sail spread in running, as spinnakers are not usually allowed; nor, indeed, are they practicable from a racing point of view. In this case the mainsail does all the driving, but the very small foresail is absolutely necessary for steadying purposes. For beating and running nothing can equal this rig, but it is slightly slower for reaching than that shown in Fig. 39.

When determining the proper proportions of length, breadth, depth, and displacement, the following rule for ascertaining the displacement will be found very handy:—Length on load water line × L.W.L. breadth × depth of hull below L.W.L. × ·015 (constant), the result being the approximate displacement in pounds. The rule applies only to fin-keel yachts. Care must be taken to embody the elements of speed in the design; these may be briefly summed up as follows: — (1) The less body there is in the water the smaller is the resistance to movement of that body. (2) A medium full bow that will cut the water cleanly and with easy entrance. (3) A fair freeboard and sheer. (4) A medium deep and beamy upper body with moderately well-marked bilge. (5) Convexity of the cross-sections where the sides of the boat join the deck. (6) Overhangs just long enough to gracefully carry the lines out fore and aft. (7) The under body narrow and deep. (8) As large a sail spread as the spars will stand. It should also be borne in mind that a boat which is tender at small angles of heel and stiff when well over will go far more steadily and point higher in light breezes than a very stiff boat.

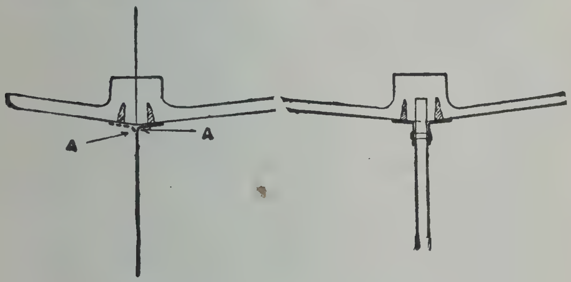


Fig. 41. Fig. 42.

Fig. 41.—Fixing Metal Fin to Yacht Hull; Fig. 42.—Fixing Wooden Fin to Yacht Hull.

Fastening on the fin of a fin-keel yacht is no easy job. Fig. 41 shows the method of fastening an aluminium or brass fin, which is flanged alternately port and starboard. In flanging the aluminium, care must be taken to soften the bends A A by holding the sheet over the fire until almost red-hot, and then allowing it to cool gradually. If this is not done the piece will break off short whenever an attempt is made to flange it. Fig. 42 shows a method of attaching a wooden fin to the keel. The fin is tenoned for $\frac{1}{2}$ in. into the keel, and brass angles $\frac{1}{2}$ in. by $\frac{1}{2}$ in. by $\frac{1}{16}$ in. running the whole length of the fin are riveted, as shown, both to the fin and the keel or bottom of the boat; this makes a very substantial fastening. In any case avoid putting the fin entirely through the bottom. as the racking is sure to produce leaking.

After all, the sails are of the most importance, and they are worthy of the greatest thought and care in planning and cutting, and in fixing on the spars. The mainsail of a large racing yacht has not a straight line to it; the head, luff, foot, and leach being all rounded more or less. In models, however, the selvedge edge is usually made the leach, and is therefore straight, as is also the luff, but the other sides should be rounded as follows :—Head, $\frac{3}{16}$ in. per foot; foot, $\frac{1}{8}$ in. per foot. Fig. 43 shows a method of fixing the mainsail to the spars, which has been very successful in allowing sails to draw properly when filled with the wind; the flexibility of the cord A A equalises the strain and prevents "hard places" showing up. B, B, B are screw-eyes on the boom, spaced about 4 in. apart; C, C, C, C are $\frac{1}{8}$-in. rings sewn on to the hem of the sail. The cord A A is passed through all these rings and eyes, and fixed at each end of the boom. The same arrangement applies to the mast and gaff.

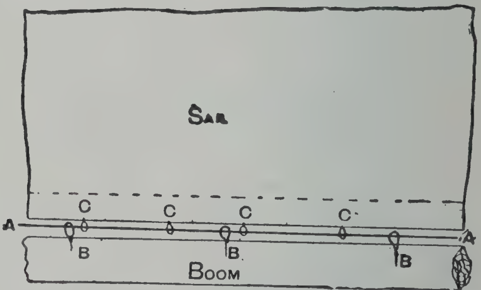


Fig. 43.—Arrangement for Connecting Sail to Spar.

CHAPTER III.

MAKING AND FITTING SIMPLE MODEL BOATS.

In the preceding chapters, the building and sailing of model yachts are considered from what may appear to some a slightly advanced standpoint. The information given in this chapter is intended primarily for those who have not had a previous insight into the art; for all that, however, the subject matter will be found thoroughly practical, though the endeavour has been to make it simple and capable of being easily understood.

Before commencing the construction of a boat, it is necessary to obtain a piece of wood of suitable size and shape out of which to make it. It is an essential that the wood be free from cracks and knots, quite dry, and capable of being easily worked.

Having cut a block to the right dimensions, rule a line lengthways right round it exactly down its centre, passing down the middle of the deck, keel, and bow. Then rule a line on each side of the keel line to represent the thickness of the keel (Fig. 44). The block is now ready to be cut into shape. Fig. 45 is an outline of the more general shape of the hulls of cutters and schooners. The widest part is usually at a distance from the bows equal to one-third of the entire length The relation between the width and length varies a great deal, but a good width is one which is a quarter of the length, whilst the depth may be about three-fourths of the beam, exclusive of the lead keel. If the boat is to be a steamer, the width and depth must be much less in proportion to the length. In Fig. 45 from A to B the hull is built up; by this is meant that it is composed of a strip of wood fastened on to the principal block. A wooden keel fixed on to the lower part of the block extends from C to D, and a metal keel extends underneath this from D to E. The dimensions of the various parts of the boat must be determined before the block of wood is chosen, and its depth must be equal to the distance from B to C.

In cutting the block to shape, begin by roughly chopping out the interior, leaving the sides about ½ in. thick. To do this, bore holes with a 1 in. centre-bit, close to one another all over the part to be cut out, and then chisel away the intervening wood. Then turn the block upside down, and shape the outside. With a chisel chop out the keel, except at the widest part, where there is no keel at all (Fig. 45), to the depth of ½ in. The position of the keel is now so marked that it cannot be obliterated. The sides

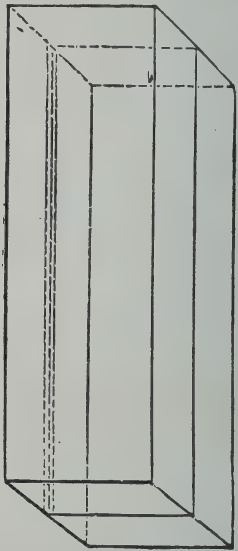


Fig. 44.—Block of Wood for Hull of Boat.

should be shaped first with chisel and then with spokeshave or plane, and they should curve with a continual graceful bend (see Fig. 46). When nearly reduced to the right size, see that both of the sides have the same shape. If satisfactory, shoot the top of the hull and the keel quite true with a trying plane, and cut the bow and the part of the keel where the rudder is placed quite straight with a chisel. The flat part of the hull, near the stern, can be finished off with a small iron smoothing plane; its upper part should be slightly thicker than the lower part.

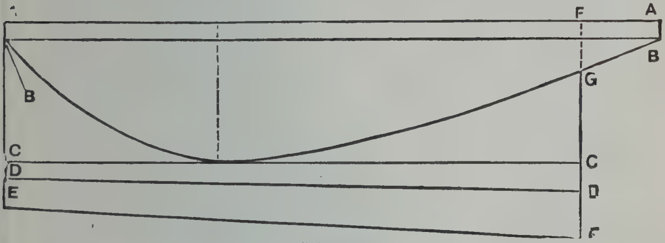


Fig. 45.

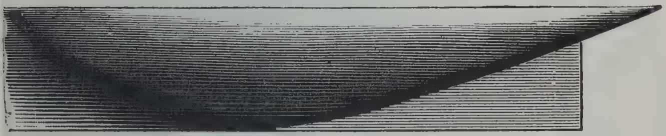


Fig. 46.

Fig. 45.—Shape to be given to Hull; Fig. 46.—View of Hull.

The interior should now be finished off. It should have a curve corresponding to that of the sides, and the wood must be chopped out in small pieces until the sides are sufficiently thin. The thickness of ½ in. is quite enough for the sides of a boat 36 in. long. The interior may be neatly finished off with a smoothing plane, the sole and iron of which have been rounded to adapt them to the curvature.

The wooden keel is a strip of wood whose edges have been shot quite true, and it is fixed to the hull by three or four long screws. It must be wider at the end which is placed at the stern than at that which is placed at the bows; care must be taken that it does not lean to one side.

When the hull has been finished, the deck may be fitted to the hull with nails or screws, its edge being allowed to overlap slightly. The deck is a board thicker in the middle than at the sides, so that the water which washes over it will run off more easily, and it is strengthened underneath by braces of wood fastened across it. Before fastening down, all mast holes and hatchways must be cut in it, and, if wished, it can be ruled with lines to represent the joints between the deck boards, the lines being afterwards slightly indented with a bradawl.

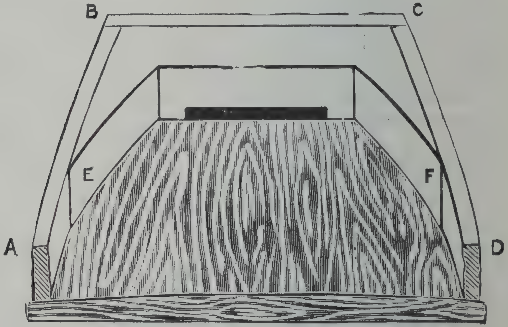


Fig. 47.—Wood to form Scuppers.

Before fixing the metal keel, bore a hole near the stern for the reception of the upper part of the rudder Bore a small hole with a gimlet through the deck and hull along the dotted line F G in Fig. 45, and then bore a larger hole down this one with a centre-bit of suitable size. Procure a piece of brass tube which will fit tightly into this hole, hammer it in, and file its ends off flush with the wood.

A lead keel is cast in a wooden mould, as described on p. 29, but if the keel is of iron it must be forged. The keel is thicker and wider at the end which is placed at the stern than at the other. It is fitted on to the wooden keel by screws passing through holes bored in it. A lead keel is preferable to one of iron.

The scuppers consist of a piece of wood shaped as in Fig. 47, so that it will fit into the end and sides of the deck at the stern of the boat; it is fastened down with screws, which should be countersunk. A long shallow groove is cut underneath the central part of it, large enough to allow any water which may be shipped to escape. In Fig. 47 the line passing through A, B, C, and D is the upper edge of the bulwarks, and the carved piece of wood passing from E to F is the scuppers. A thin piece of wood is then fastened on to the back of the scuppers; this is wide enough to cover the part of the hull above which the scuppers are placed and the ends of the bulwarks. The portion of the hull so covered is represented by A B in Fig. 45, and so is below D C in Fig. 47.

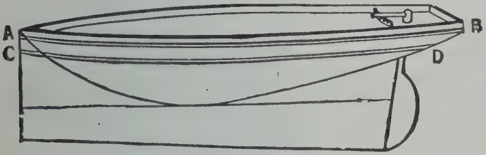


Fig. 48.—Complete Hull.

The hull must next be thoroughly glasspapered smooth all over, and the bulwarks, of ¼ in. walnut-wood, may then be fixed to the deck with nails or screws at such a distance from the edge that a ledge ¼ in. wide projects all round. A half-rounded strip of wood (C D, Fig. 48) is then fastened round the outside of the hull slightly above the water-line, and is brought to a point at the bows. A thin piece of sheet copper is nailed across the bows from the bulwarks down to the metal keel, to prevent the wood from being damaged in case a collision occurs.

The stand (Fig. 49) is now to be constructed. It consists of two oak uprights, supported at a certain distance apart by a stout wooden bar. Slits are cut half-way down the centre of each of the uprights, of such a width that the keel will fit loosely into them.

The upper part of the rudder, Fig. 50, is rounded and made to fit into the brass tube previously passed through the deck; it is of such a length that about 1 in. projects above the deck, the projecting part being reduced in size for a short length, and fitted with a piece of brass tube.

In Fig. 50, A shows the brass wire, B the brass tube, C the rounded part of the rudder, and D the part which is in the water. The brass wire, A, is about 3 in. long, and is used for turning the rudder. Instead of having its end curled up as shown in Fig. 50, a small wooden handle may be attached to it. To fix the rudder in any position a piece of brass (A B, Fig. 51), about $\frac{3}{4}$ in. in height, and having a series of notches cut in its upper edge, is fastened down to the deck in a curved position, almost above the rudder, by brass flanges, which are soldered on to it and screwed down to the deck. The brass wire coming from the upper part of the rudder is placed in any one of the notches which holds it in the requisite position; the wire presses downwards, and cannot spring upwards.

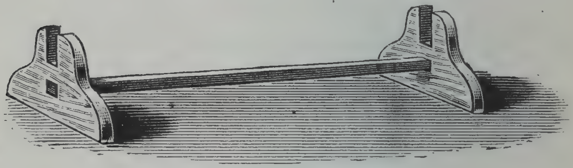


Fig. 49.—Stand for Boat.

The hull, as far as it has been made, is shown by Fig. 48, where the ledge of the deck which projects is represented by the double line A B, and the rounded strip of wood fastened just above the water-line by C D.

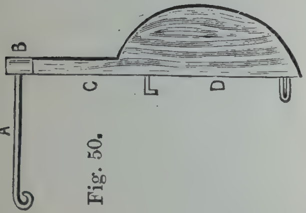


Fig. 50.

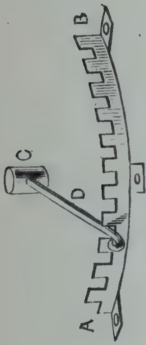


Fig. 51.

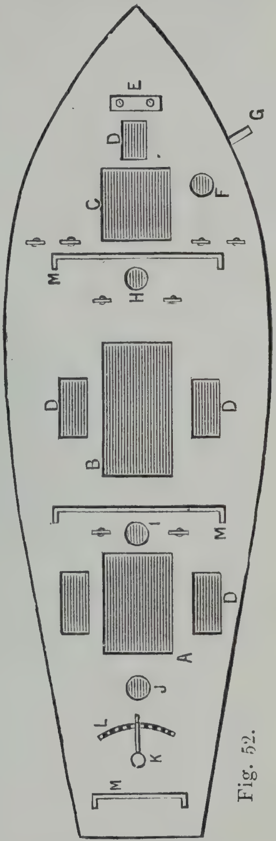


Fig. 52.

Fig. 50.—Rudder of Boat; Fig. 51.—Steering Arrangement of Model Boat; Fig. 52.—Deck Plan of Two-masted Model.

Before proceeding further it will be best to paint the hull. All cracks and holes must be stopped up with putty, and the paint laid on in thin even coats. The upper part, from the top of the bulwarks to C D, Fig. 48, may be painted black. The lower part, with the exception of the keel, if the latter is made of lead, can be painted with vermilion, dark red, or brown paint. The belt may be painted white or gold. After painting, the whole must be varnished. The deck can be varnished or left plain, as desired. More information on stopping and painting the model is given on p. 50.

The deck fittings must now be arranged in their places. Fig 52 is a plan showing how the deck fittings of a two-masted vessel can be arranged. The rectangles A, B, and C are hatchways, those represented by the letter D are skylights, E is a piece of wood which holds the end of the bowsprit, F is the capstan, G is a piece of wood which supports the anchor, H is a hole into which the foremast is fitted with the aid of a socket, I is a similar hole for the mainmast, J is the binnacle containing the compass, K is the top of the rudder, L is the brass arrangement for fixing the top of the rudder, and the lines denoted by the letter M are brass wires along which ropes attached to the jibs and mainsails slide in tacking. The short lines or dashes near the mast holes are cleats on to which the ropes which regulate the sails are fastened. The number and size of the deck fittings may vary. They are easily put together, or can be bought ready-made. If the boat is about 4 ft. or 5 ft. long, a small brass bell, in imitation of those used on real ships,

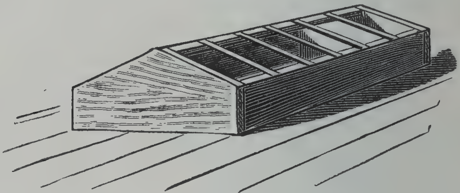


Fig. 53.—Skylight for Deck.

may be suspended in front of the mainmast, and several swivel cannons may be fastened on the deck in various positions. A few small boats may also be secured to or suspended above the deck, in such positions as not to interfere with the free motion of the sails.

It is best to determine the number and size of the deck fittings before the deck is fastened down. The holes to receive them must be neatly cut out with a keyhole saw or bored with a centre-bit.

The simplest kind of hatchway is made by constructing a box of thin wood without any top or bottom to it, and of such a size that it will fit tightly into the hole previously cut in the deck, and project a little above it. A lid is made to slightly overlap it, and is fastened on with two hinges. A hole may be cut in the lid, and fitted with a piece of glass to form a skylight. It may be fastened firmly down, so that no water can get into the hold. The skylights may be constructed in the same way that the hatchways are, only with glass roofs instead of wooden lids; or they may consist of plain pieces of glass let into the deck.

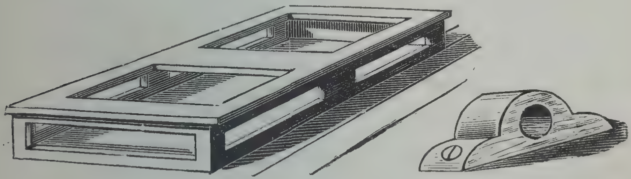


Fig. 54. Fig. 55.

Fig. 54.—Skylight for Deck; Fig. 55.—Socket for Bowsprit.

For circular skylights, lenses fastened into a round hole with putty can be used. They may also be constructed in the forms shown in Figs. 53 and 54; but these are rather complicated, and should only be used on a 5-ft. boat. The pieces of glass are fastened into the wood with putty and protected by pieces of brass wire fastened across them. The skylights can also be constructed of an oval or hexagonal shape, and may have curved roofs.

The piece of wood (E, Fig. 52) which holds the end of the bowsprit is shown in Fig. 55. A hole of very slightly larger diameter than that of the bowsprit is bored about half-way through it, and it is fastened down to the deck with two screws.

The capstan is shaped something like Fig. 56. It is turned out of boxwood, and its lower part is made with a dowel, which fits into a hole bored in the deck. The rope from the anchor is tied on to its middle part and wound round it. It can be made with a cog-wheel and spring catch arrangement, so that the rope can be wound up by simply turning it round. A hole is bored through the bulwarks near the capstan for the anchor chain to pass through, and a small piece of brass tube is fitted into it to prevent its sides from being worn away.

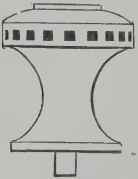


Fig. 56.

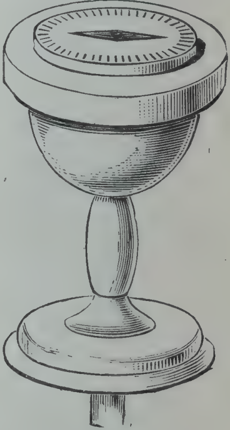


Fig. 58.

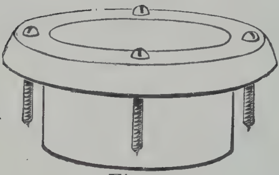


Fig. 57

Fig. 56.—Capstan; Fig. 57.—Mast Socket; Fig. 58.—Binnacle.

The support for the anchor (G, Fig. 52) is simply a flat piece of wood fitted into the lower part of the bulwarks. A loop of string hanging down from it holds up the fluke of the anchor. One end of a long piece of chain or whip-cord is attached to the anchor, and the other end is fastened to the capstan, round which the remaining part of it is wound.

The mast-holes are bored in the deck with a centre-bit, and wooden sockets (Fig. 57) are fitted into them. Each socket is turned out of boxwood, and is fastened into its place with four small screws. The binnacle (Fig. 58) is also of boxwood, and its upper part is hollowed out to contain the compass. It is fitted into the deck in the same way that the capstan is. The compass can be bought at any model shop, and should be less than 1 in. in diameter. The pieces of brass wire (M, Fig. 52, page 63) are shaped as shown in Fig. 59. The pointed ends are hammered into the deck, care being taken not to split the latter. The cleats are made in wood and brass in the shapes shown in Figs. 60, 61, and 62. That shown by Fig. 60 is fastened down by two small screws passed through it; the others have pointed ends, so that they can be hammered into the deck. Fig. 63 shows the manner of mounting cannons with a swivel arrangement. The lower end of the support of the trunnion is pointed, so that it can be fastened on to the deck by simply hammering it in.

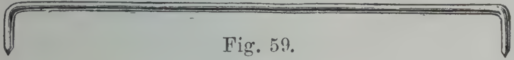


Fig. 59.

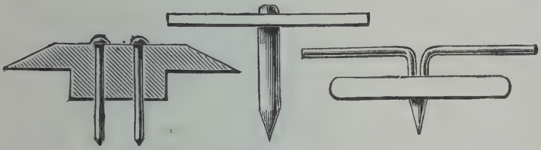


Fig. 60. Fig. 61. Fig. 62.

Fig. 59.—Brass Slide for Sheets; Figs. 60—62.—Cleats.

These are all the deck fittings generally used on two-masted models. If a one-masted vessel is being constructed, the only difference in the arrangement of the deck fittings will be that only one mast-hole, two pieces of bent wire, two hatchways, and fewer skylights will be required.

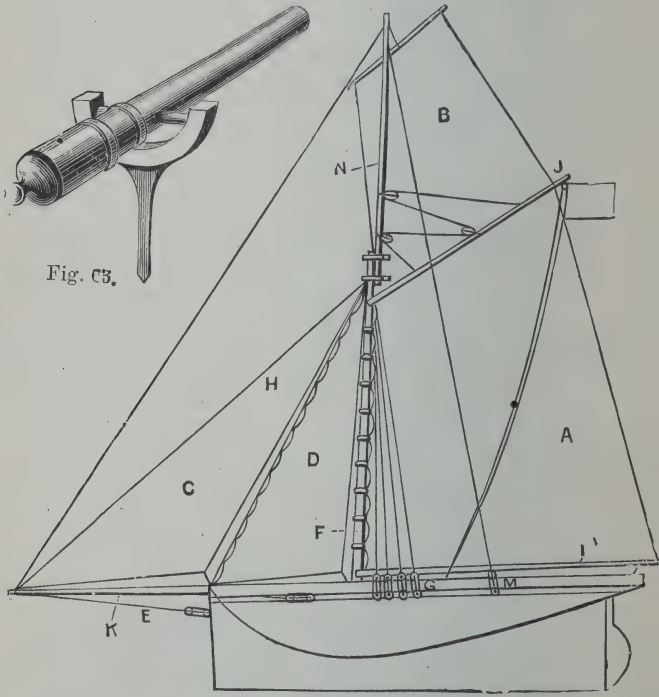


Fig. 63.

Fig. 63.—Model Cannon; Fig. 64.—Rigged Cutter.

A few touches of paint must now be applied to the hull and deck. All iron eyes and heads of screws must be touched up with black paint, and a few touches of red and black paint may be added to the skylights to improve their appearance. A figurehead can also, if wished, be fixed on to the bows.

Fig. 64 shows the manner in which a cutter may be rigged. There is one mast, F, on the top of which is a topmast, N. It has a mainsail, A, a topsail, B, and jib and foresail, C and D. The mainsail is fastened to a spar, J, called the gaff, and to another spar, I, called the boom. The mast is supported by shrouds, G, and by a forestay, H. The bowsprit is secured by a stay, E, and two sidestays. The mainsail and foresail are fastened to rings which run along the wires, M (see Fig. 52), by strings called "sheets." The sails are let up and down by strings called halyards, which pass

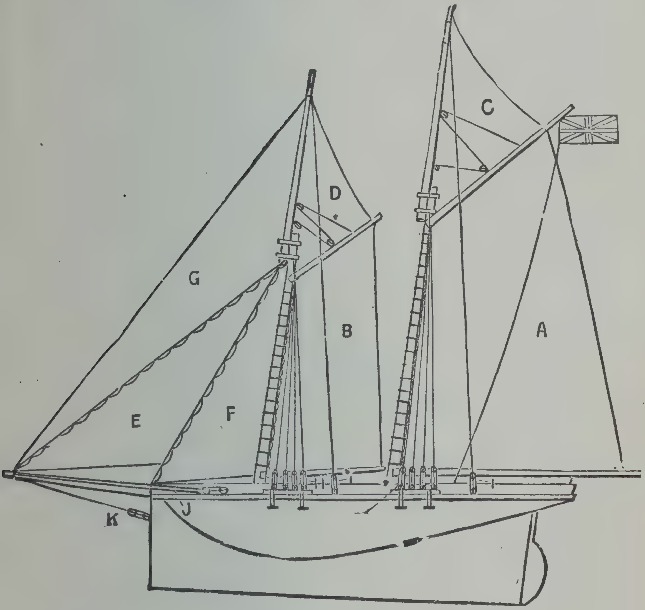
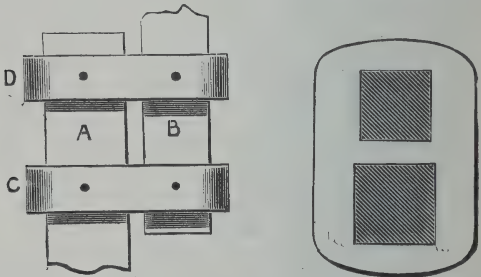


Fig. 65.—Schooner.

over pulleys and down to the deck, where they are fastened round cleats. The mast is sometimes provided with two back stays (M, Fig. 64), which pass from the topmast and are fastened on to the outside of the hull, but nearer to the stern than the shrouds.

Fig. 65 is an illustration of the rigging of a fore-and-aft schooner. The letter references are as follows:—A, mainsail; B, foresail; C, D, topsails; E, jib; F, fore staysail; G, foretopmaststay; H, mainstays; I, backstays; J, K, stays to bowsprit. The topsail on the foremast may be replaced by one or two square sails, when the boat will be a topsail schooner. The square sails add much to the appearance when she is upon the water, and make her sail with great speed before the wind; but they add greatly to the weight of the topmast, since three yards are required on each mast. In tacking, the yards are moved by braces, which pass over pulleys fixed on to the opposite mast, and thence down to the deck.



Figs. 66 and 67.—Arrangement for holding Main and Top Masts.

Having determined the manner in which the model is to be rigged, proceed to make the masts and spars of deal or lancewood; the latter is to be recommended, because it can be obtained in long strips, is of a good colour, is hard and flexible and can be made very smooth. The masts are made to fit tightly into the sockets provided for them. The topmast is joined to the mainmast by the arrangement shown in Fig. 66, where A is the mainmast, B is the topmast, and C and D are two pieces of boxwood of the shape shown in Fig. 67.

The point of a nail is driven into the lower part of the masts, so that they will not be able to slide about in the hold of the vessel. The ends of the topmasts are provided with boxwood or brass trucks. Small brass eyes are fixed on to the mast in the various places where ropes are to be attached. The bowsprit is made to fit into the piece of wood which is fastened to the deck for its reception, and a ring is rigidly fixed on to the bows for it to pass through. The gaffs and booms are made in the shape shown in Fig. 68. They should be made as light as is consistent with strength, and should taper almost to a point. The curved part clasps the mast, and is tied to it with a piece of string, but so loosely that it will easily slide up and down. It may be cut out with the spar, or made by joining pieces of wood on to the spar, in the manner shown in Fig. 69. An eye, to which the halyard is fastened, is fixed on to the upper side of the gaff, and another, to which the sheet is attached, is fixed on to the lower side of the extremity of the boom.

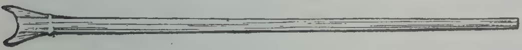


Fig. 68.—Gaff or Boom.

The shrouds are usually three or four in number, and are fastened to the top of the mast, close to the crosstrees, and to the outside of the hull, a little above the bulwarks They are made of whipcord, and their lower ends are secured by a sliding arrangement (Fig. 70), or by means of deadeyes. In the sliding arrangement, a piece of wire (Fig. 71) is tied on to the end of the stay, a hook is threaded on to it, and then the other end is passed through the other hole in the bent piece of wire, and fixed in its place on the mast.

When this is done, the arrangement will be in the position shown in Fig. 70. The hook is fixed on to the brass eye fastened outside the hull, and the bent piece of wire is slid up the stay until the whole is stretched quite tight. A shroud fixed in this manner is shown in Fig. 72, in which A is the stay, B the piece

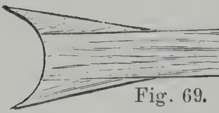


Fig. 69.

Fig. 71.

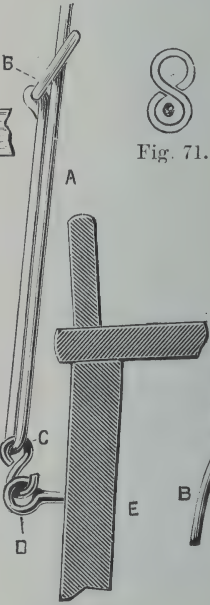


Fig. 72.

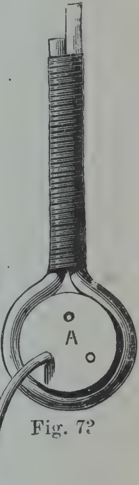


Fig. 73.

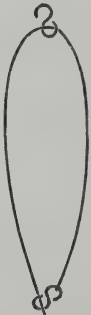


Fig. 70.

Fig. 69.—End of Gaff; Fig. 70.—Stay fitted with Hooks; Fig. 71.—Stay Hook; Fig. 72.—Method of Fixing Stay to Hull; Fig. 73.—Deadeye fitted to Stay.

of bent brass, C the hook, D the eye, and E part of the hull.

The method of fixing the shrouds by means of deadeyes is more complex. The deadeyes are round pieces of wood about ½ in. in diameter or less, according to the size of the boat. A groove is cut round the circumference, and three holes are bored through each. The stay is attached to the deadeye by being passed round it and bound up with fishing string in the manner shown by Fig. 73. A piece of string, B (Fig. 73), about 16 in. long, and having a knot tied at one end, is drawn through a hole in each deadeye until the knot prevents it from going any further. These pieces of string are for attaching to other deadeyes which are fitted on to the outside of the hull. When all the shrouds have been treated in this manner, they are tied up in a bunch, and fixed on to the main mast in such a position that the deadeyes are about ½ in. above the bulwarks. Their number may be varied according to wish, but four are, as a rule, employed.

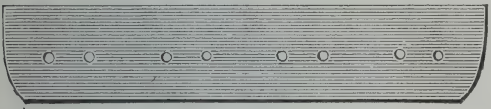


Fig. 74.—Wood to which Lower Deadeyes are fixed.

The lower deadeyes must now be fitted on to the hull. A strip of boxwood, of the shape shown by Fig. 74, and having eight holes bored through it in the position shown by the dots, is fixed on to the outside of the hull just above the projecting ledge of the deck. It may be further strengthened, if necessary, by fastening a piece of brass wire from each end of it to a brass eye screwed on to the hull a little lower down. A piece of brass wire is wound round each deadeye, and its two ends are passed through a pair of holes in the strip of wood, and securely fastened underneath it. A cleat is fastened on to the hull at each end of each strip of wood. The strings in the upper deadeyes are then threaded alternately through the holes in the lower and upper deadeyes until all the holes are filled up, when the end is wound round a cleat. When each shroud has been secured in this manner, the lower ends of the shrouds which secure the mast on one side of the hull will have the appearance presented by Fig. 75, in which A is the strip of wood (Fig. 74), B, B are the cleats, and C, C are the wires which are attached to strengthen A.

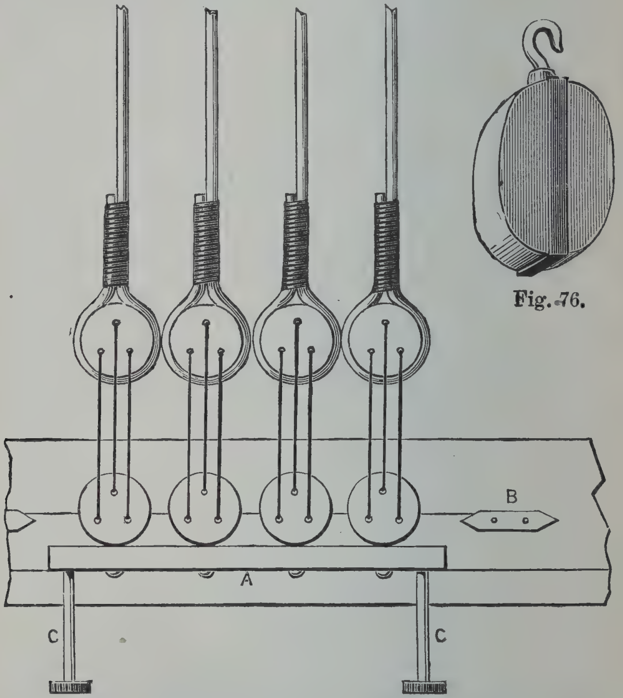


Fig. 76.

Fig. 75.—Set of Stays fitted with Deadeyes; Fig. 76.—Block Pulley.

The best way of making the sails of the right size is to cut paper patterns, carefully measuring the various dimensions, and then to cut them out from the patterns and hem all round. The material of which they are made has already been mentioned. Before fitting them in their places, some blocks must be procured, and fixed on to the masts for the halyards to pass over. One of these must be fastened on to

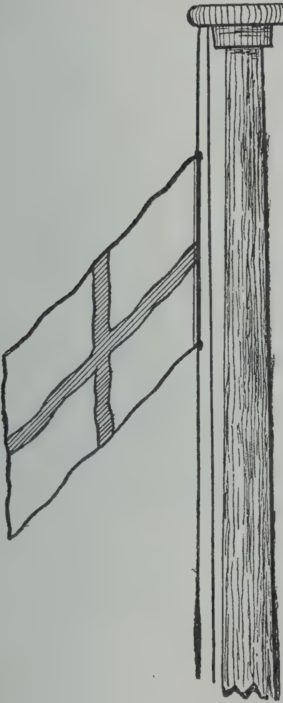


Fig. 77.—Method of Hoisting Flag.

each gaff, in the position shown in Fig. 64, and on to the topmast. Two more must be fastened on to the foremast, near the crosstrees, for the halyards belonging to jib and foresail to pass over. An extra block may be fixed on to the end of the gaff for raising or lowering a flag. These blocks (Fig. 76) are made with or without sheaves and are simply pieces of wood having a hole bored through, and surrounded by a piece of wire, one end of which is bent into the form of a hook. The block is hooked to a brass eye screwed into the mast.

For fixing the sails in their places, several yards of fishing string will be required. Pieces of string are tied on to the gaffs to form the halyards, and are passed over pulleys down to the deck, where they are secured after the gaffs have been hauled up into their right positions. The booms are fitted with sheets, which are tied on to rings which slide along bent wires (M, Fig. 52). The fore and main sails are tied on to the gaffs and booms, and on to rings which slide up and down the masts. The topsails are hooked on to the end of the gaff and on to the mast with small hooks made of copper wire. A forestay of whipcord is fastened on to the front of the foremast at the crosstrees, and to the deck at the bow, and the forestaysail is fastened along it by means of rings, so that it will slide up and down. Both the forestaysail and the jib are hauled up and down by halyards in the same manner that the mainsail is, and are fastened to the deck and bowsprit by short pieces of string tied to brass eyes.

Sometimes halyards for the purpose of raising or lowering flags are rove through the truck at the masthead as shown by Fig. 77.

CHAPTER IV

BUILDING A MODEL ATLANTIC LINER.

THE steamer to be described in this chapter is built on the lines of a modern Atlantic liner, and measures 4 ft. 4½ in. between perpendiculars, 9¼ in. beam, whilst the depth at the midship section, from the load water-line, is 8 in. The vessel will have a fore-raking stem, which will cause her over all length to be 5 ft. 10 in. This length, besides being convenient for show purposes, enables the boat to hold boiler and machinery capable of propelling the vessel through the water at a fair speed.

The liner, Fig. 78, is not over-hampered with cross-yards, pole masts being the best form of rig for a racing model. The *Teutonic*, one of the fastest transatlantic steamers, is rigged similarly.

In determining the most desirable shape of vessel to obtain great speed, it must be remembered that the beam of a vessel must be proportionate to its length. The ratio of 7 to 1 is found to be a most suitable proportion for cargo-carrying steamers, but for large liners and some other classes of steamers, a more easily propelled displacement is desirable, in order to gain greater speed; therefore the ratio has been increased to the proportion of 11 to 1. The draught of the *Teutonic* gives a reasonable proportion of 15 to 1, considering that the length of this vessel is 582 ft. between perpendiculars; a beam of 37 ft. 6 in. is thus given. With the model liner now being considered, such a proportion would result in only 4-in. beam, so a ratio of about 7½ to 1 is adopted, giving a beam of 9¼ in.

The resistance that the vessel has to overcome regulates the speed, and with this model almost the whole resistance may be reckoned as the skin friction

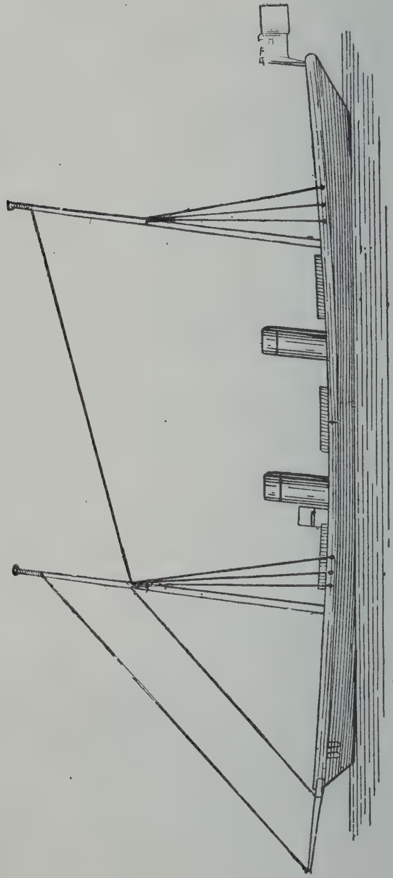


Fig. 78.—Model Atlantic Liner.

The skin resistance of a vessel depends upon the immersed surface in square feet multiplied by the velocity in knots per hour squared, and multiplied by the coefficient for surface. Co-efficient for surface = ·007 for smooth copper or brass sheets, and ·01 to ·014 for painted sheet metals. Therefore the endeavour should be to make the model on as fine lines as possible, to not have a superfluous amount of wetted surface, and to give it a form that will cleave and not push its way through the water.

The sheer draught of the model liner is represented by Figs. 79, 80, and 81. Fig. 79 is the sheer plan, which, to assist in accurately obtaining the curvature of the hull, has been divided between perpendiculars into seventeen equal stations, each representing a mould by which the plating of the model is to be built to the proper form.

The three plans, Figs. 79, 80, and 81, may be laid down upon a scrieve-board, or they may be drawn on paper. If the latter method is adopted, build up a drawing-board 8 ft. long by 4 ft. broad, and upon this stretch a piece of cartridge-paper of about the same length.

Commence with the sheer plan, which shows the general outline of the hull looking on the starboard side. As is probably known, the starboard is the right-hand side when facing the bow, the larboard or port being on the left. Draw a line from left to right, about 15 in. or 16 in. from the top of the board, and extending the full length. This is the load water-line (L.W.L.).

The line of the "spar" deck or "flush" deck is next to be drawn. At a distance of 4 ft. from the right-hand end of the board draw a line, at right angles to and crossing the L.W.L., from top to bottom of the board; this line will be the line of midship section X Two and a half inches above the L.W.L., upon the line X, a point must be marked; at No. 17 station, and at No. 1 station a distance of 4 in. must be marked, and then striking an arc through these three points the line of the deck is obtained. At No. 1 station mark downwards a distance of 1¼ in.; mark the same distance at No. 17

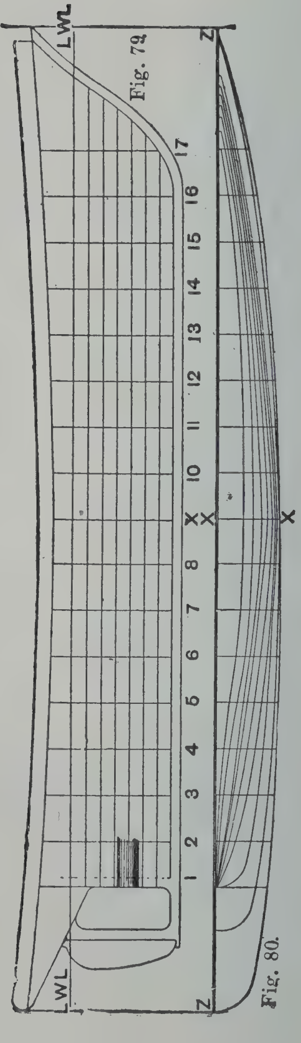


Fig. 79.—Sheer-plan of Model Liner; Fig. 80.—Half-breadth Plan of Model Liner.

station, and at the midship section mark down from the line of the hurricane deck a distance of 1 in.; striking an arc through these three points will give the line for a beading or moulding to be run all round the vessel to improve her appearance. For the line representing the bottom of the keel, fix upon a point 8 in. below the L.W.L., and draw a line right across the board; the vessel will now measure in height from the keel 12 in. at stem and stern, and at the midship section $10\frac{1}{2}$ in.

To give the necessary rake to the stem, measure to the right of No. 17 station a distance of $8\frac{3}{4}$ in., and through this point draw a line from top to bottom of the board, and at right angles to the load water-line; this line cutting the line of the deck determines the extreme length forward at this point. The form of the stem can now be struck in as shown in Fig. 79.

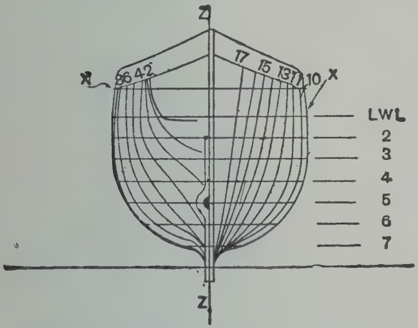


Fig. 81.—Body Plan of Model Liner.

The propeller aperture and the counter are next to be considered. The propeller aperture is to be 3 in. measured fore and aft, and the counter is to be 5 in., measuring from the after end of the rudder-post; the forms of these are shown in Fig. 79. In drawing down the space for the propeller aperture, keep it as large as possible, in order to get into it a screw propeller of large enough diameter. To effect this better, the body, or stern-post, and the rudder-post are made in one piece.

The inverted half plan, Fig. 80, known as the half-breadth plan, shows the longitudinal transverse section of the vessel at the load water-line, and at other water-lines parallel to it.

Fig. 81 is the body plan; the right-hand portion of the middle line z z sets forth the curve of every station from No. 17 to the midship section, being the fore body; whilst the left-hand portion of the same plan sets forth the curve of every station in the after body, that is those from No. 1 station to the midship section x.

It is usual to lay down the body plan to the left of the sheer plan, continuing the load water-line and every other water-line down to the keel right across the board. To get the curve of each station, measure accurately with dividers the distance where each station cuts the water-lines on the half-breadth plan, and transfer that distance to the body plan, the distance to be measured from the middle line z z, and again marked off from the middle line on the body plan. Each water-line must be treated in this manner until both fore and after body are completed; the curves may then be drawn in through the points got in this manner, when this plan may be said to be completed. It will be advisable to lay down on a scrieve-board each station separately, both port and starboard side, in order that the station may be properly "faired," so that one side of the steamer will be of equal displacement with the other: or, in other words, one side of the model will be a

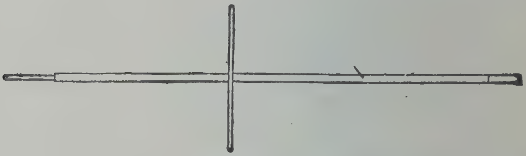


Fig. 82.—Plan of Stem of Model Liner.

true right hand, whilst the other will, in its turn, be a true left hand to it.

Three plans of the vessel having been laid down, the necessary working drawings to make the fittings, etc., for the hull must be prepared.

Commencing with the stem, shown in plan and elevation by Figs. 82 and 83, a bulkhead or athwartship division plate is made strictly to the form of No. 17 station. The stem, which, together with the division plate, is made of sheet brass, is shouldered down and riveted firmly to the division plate, the exact positions being taken from the sheer plan. The reason for building up the stem in this manner is to add strength to that portion of the hull which should be the strongest part of a model, or, in fact any steamship, and to lessen the likelihood of the vessel filling and sinking should it come into collision whilst being propelled through the water.

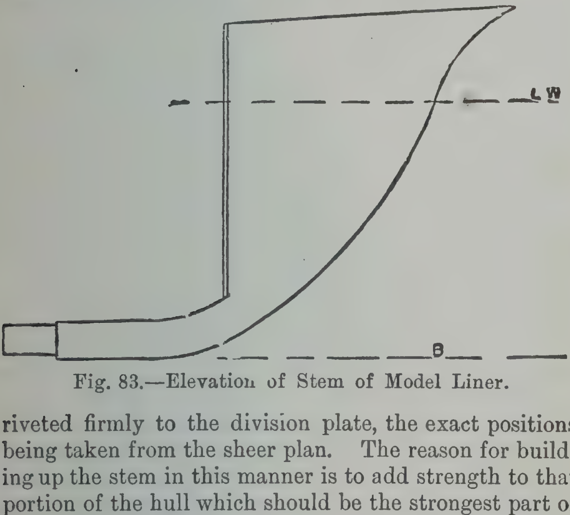


Fig. 83.—Elevation of Stem of Model Liner.

Fig. 83 shows the stem scarped or thinned away for jointing to the keel. It is shouldered down carefully, as shown, for a distance of $1\frac{1}{2}$ in., in order that it may be driven into the keel, and riveted therein by means of five $\frac{1}{16}$ in. countersunk rivets. The stem is to be further secured to the keel by sweating-in with solder, afterwards neatly smoothing with a file.

The keel is 48½ in. long, and is made from a piece of brass or copper tube ¾ in. inside and ⅞ in. outside diameter. It is first annealed by heating it to a very

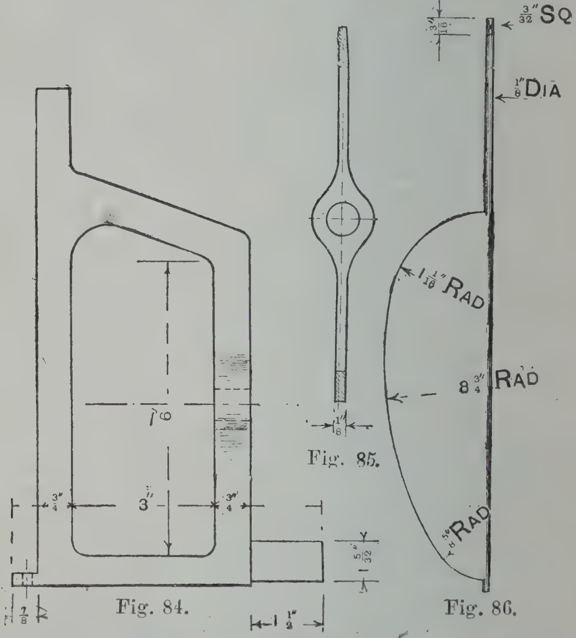


Fig. 84. Fig. 85. Fig. 86.

Fig. 84.—Side Elevation of Stern and Rudder-post; Fig. 85.—Sectional Elevation between Stern and Rudder-post; Fig. 86.—Elevation of Rudder.

dull red heat and plunging it into a trough of clean water, and it is flattened for the full length by placing it over a flat metal surface, and beating with a wooden mallet. Straighten it up by using a broad facing hammer, applying a straightedge to the edges and sides until assured that it is perfectly straight and out of winding; draw-file it to a proper surface, in order that the garboard or lower strake of plating may be soldered to it. It should now measure 48½ in. in length by 1⅜ in. in breadth by ⅛ in. in thickness; this is the thickness of stem, stern, and rudder-post.

A fine steel drift, $1\frac{5}{32}$ in. broad and $\frac{1}{16}$ in. thick for a distance of 1⅝ in. from the point, should now be prepared. This drift is driven into each end of the flattened tube which forms the keel, thus creating a cavity to receive the scarp or shouldered-down part of the stem at the fore end, and at the after end to receive the shouldered-down part of the stern-post.

Fig. 84 is a side elevation of the stern and rudder-post (which are to be made in one piece), whilst Fig. 85 is a sectional elevation looking from aft, and showing the hole for the stern tube. As previously stated, the aperture for the propeller is to be 6 in. high at the smallest part, and 3 in. in breadth fore and aft. It is advisable to have a brass casting for the stern and rudder-post. Figs. 84 and 85 are fully dimensioned, so there should not be difficulty in making a pattern for them, bearing in mind that $\frac{1}{16}$ in. must be allowed on all sides for filing up to the finished sizes, and that another $\frac{1}{16}$ in. must be allowed for contraction. The boss should be cast solid and the hole, after the casting has been filed true and the ends of the boss squared, must be drilled $\frac{1}{16}$ in. smaller than the outside diameter of the portion of the stern tube that goes into it, and afterwards properly lined off and drilled or otherwise rimed out to the finished size when the hull of the steamer has been built up, and the engines are being placed on board.

Fig. 86 shows the rudder in elevation, and Fig. 87 shows it in plan when attached to the keel and stern-post. The pintle, or lower part of the rudder, rests and must be able to freely turn in a boss or foot-step which is drilled out in the bottom of the rudder-post (see Fig. 84); sufficient length therefore must be left on the lower end of the rudder to allow for turning off

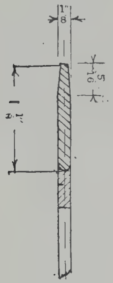


Fig. 87.

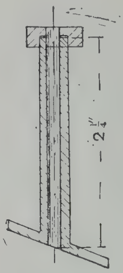


Fig. 88.

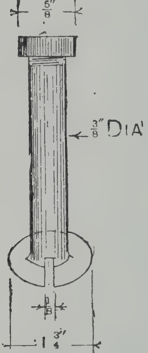


Fig. 89.

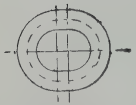


Fig. 90.

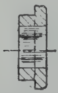


Fig. 91.

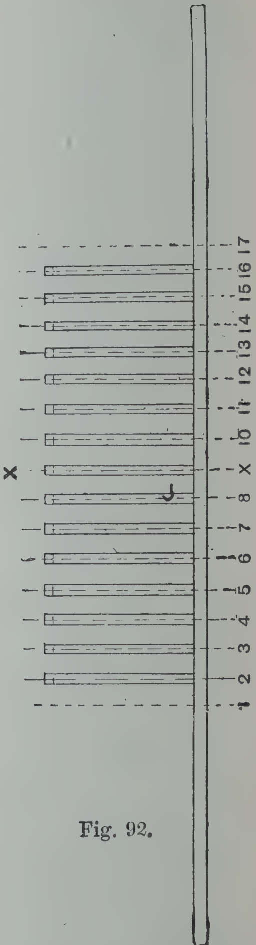


Fig. 92.

Fig. 87.—Sectional Plan of Rudder; Fig. 88.—Sectional View of Rudder-trunk; Fig. 89.—Elevation of Rudder-trunk; Fig. 90.—Plan of Hawse-pipe; Fig. 91.—Section of Hawse-pipe; Fig. 92.—Elevation of Mould-board for Model Liner.

the centre as well as for cleaning up the pintle to a diameter of $\frac{3}{32}$ in.

The stock or shank of the rudder must be turned down to $\frac{1}{8}$ in. diameter as shown in Fig. 86. After passing through the rudder-trunk, in which it should be free to turn, the shank should stand $\frac{1}{2}$ in. above the hurricane deck. The top end of the rudder-shank is squared down so as to fit the tiller without shake. The two illustrations of the rudder are fully dimensioned, and explain themselves. Should the dimensions previously given have not been strictly adhered to, there may be trouble in connection with the length of the shank; this may be got over by leaving it, say, $\frac{1}{4}$ in. too long, as it is easily cut off afterwards at convenience.

The rudder-trunk, shown in section by Fig. 88 and in elevation by Fig. 89, may be made from a solid piece of soft brass, but a casting is preferable. The flange at the bottom is made to suit the curvature of the plate at the stern. Plenty of material should be left on for fitting to the sweep of the stern; the flange can easily be reduced until it is $\frac{1}{16}$ in. in thickness. The finished casting should measure on the centre line $2\frac{1}{4}$ in., as shown in the figure, and the top forms a stuffing-box, to which is fitted a gland in the form of a milled head, so that, on the stuffing-box being packed with soft cotton lamp-wick, the gland must be placed in position and screwed up by finger and thumb. The object of employing the rudder-trunk and packed gland is that no water may be able to get inboard. When the rudder is fixed in position the rudder-trunk is soldered to the inside of the stern plates. The gland must be packed and put into position and screwed home (by hand) before the deck is soldered in its place, as it will be impossible to get the gland on to the shank after the upper deck is fixed.

Two castings are required for the hawse-pipes—one on either side of the bow. These are not absolutely necessary for a model, and are not used for racing purposes, but they give a more finished appearance.

Figs. 90 and 91 show the hawse-pipes in plan and section. In order that they may lie snug with the bows, their pattern should be made and fitted to the hull after the holes to receive them are cut. They should be neatly filed up to shape, and when brought up to fit the bows should be soldered in position.

For making the hull, use "hard-rolled" sheet brass, No. 24 B.W.G., the thickness of which is equal to ·022 in. Two 7-lb. plates will be required, and this is obtainable at most ironmongers.

Figs. 92 and 93 are the elevation and midship section of the mould-board upon which the hull is to be constructed. As before intimated, No. 17 station is to be made of sheet brass to form a collision bulkhead; therefore, being firmly fitted to the cut-water, it will not require a mould. As No. 1 station is represented by the stern-post, no mould will be required for this. Every other station must, however, be accurately marked out on separate pieces of hard wood and sawn out correctly to the lines thereon drawn. The moulds are to be not less than 15 in. high, and their thickness is not to exceed ½ in. As shown in Fig. 93, which represents the mould of the midship section, a groove, A, is to be cut; the breadth of this is equal to the thickness of the vessel's keel, and the depth to half the depth of the keel. The groove must be exactly on the centre line of the mould, which otherwise will be useless.

Having prepared all the fifteen moulds, and carefully checked them as regards their accuracy, procure a board of 1-in. yellow pine 7 ft. long by 1 ft. wide and dress it up square. Mark on it a centre line to represent the middle line of the vessel's keel, and in the middle of the board draw a line from side to side at right angles to the centre line. This line will correspond with the line of midship section. Mark off all the stations as they occur, both fore and aft. Then fix the hardwood moulds to the mould-board, bearing in mind that the fore portion of the mould must rest on the line representing its particular station; these moulds are either to be tenoned in neatly, or they may be fixed in position by screws coming up from the under-side of the mould-board.

As the edges of the moulds have been sawn square down, or, in other words, parallel with the centre line of the mould-board, this will not give the true curvature of the hull as far as the fore and aft sweeps are concerned. The moulds are to be pared down with a chisel on the after side of the station that they respectively represent, leaving only about ⅛ in. of flat on the fore side of their edges; this will be ample for a guide in the plating of the hull.

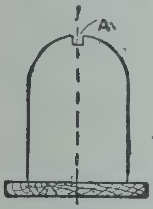


Fig. 93.

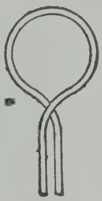


Fig. 94.

Fig. 93.—Midship Section of Mould-board; Fig. 94.—Steel Wire Cramp.

In order to test the proper fore and aft curvature, procure a thin lath of wood that may be easily bent along the edges of the moulds. For this purpose a strip of Venetian blind lath, ½ in. wide, planed down to something like $\frac{3}{32}$ in. in thickness, answers admirably. By laying the lath so that one end will rest against the mould representing the midship section, and allowing the other end to lie forward, any little irregularity that may have hitherto escaped notice can be corrected, and the length of plate required can be measured.

Now place the keel, upside down of course, in the groove A (Fig. 93), taking great care that the station No. 17 comes into its proper position, the latter having been marked off when the mould board was prepared.

In order to ascertain whether the collision bulkhead that is fixed to stem and keel is standing vertically over the corresponding line, or No. 17 station, on the mould-board, an engineer's square may be employed, letting the front bottom corner of the square blade rest against the line on the mould-board, whilst the upper part lies against the foreside of the bulkhead before mentioned. This will regulate the fore and aft position of the keel, etc., as far as the mould-board is concerned. Having determined the correct position of the skeleton of the model, fix the keel firmly in the groove A (Fig. 93) by means of hardwood wedges. See that the stem and sternposts are standing perfectly perpendicular to the mould-board; if they do not, the vessel, when floated, will have a list either to port or starboard, or will not keep a straight course when the rudder is placed amidships—that is, in fore and aft line with the keel.

The plating of the hull is now proceeded with; it may be laid on either in three or four strakes, as is most convenient. Assuming that three strakes are decided upon, commence by measuring up for the first or garboard strake. This can be done from the "sheer draught," measuring up from the keel itself, using the mould-boards as guides.

Cartridge-paper can be used for templates from which to cut out each strake before bending it to its proper form. The three strakes of plating will commence at the keel and end at the line of beading, so it will be necessary to step out equally with the dividers the distance between the keel at the bottom and the line of beading. Do this on the full-size drawing of the midship section, and thus get the broadest part of any of the strakes. Cut a strip of cartridge-paper to the width so obtained, and fit it into position as one of the garboard strakes. It will be necessary to have, say, about one dozen small cramps made out of $\frac{1}{16}$ in. steel wire (see Fig. 94), in order to hold the plates firmly in position whilst they are being soldered in place. These clamps may be utilised to hold the cartridge-paper to the keel

In making the paper patterns, much judgment must be exercised. When the paper pattern is in true position—that is when the lower edge proper, or, as it will be whilst building, the upper edge of the pattern or template is lying flush with the bottom side of the keel and the other edge of the pattern is lying parallel with the L.W.L.—take it off, lay it on the sheet brass so as not to cut to waste, mark round the template with a steel scriber, and cut neatly to the lines with a pair of sharp shears. Using the first as a template, cut another, and there will then be a port and a starboard plate.

The next thing to be done is to fit the plate itself to where the paper pattern was. Hardwood blocks dished out will have to be employed in order to form the plates to the proper curvature of the hull, using a hardwood mallet for this purpose with a convex face. After fitting one of the strakes satisfactorily, hold it with the clamps to the keel, and solder it on neatly, using ordinary soft solder with spirit of salts as a cleansing medium, the solder to be sweated in with a light hatchet bolt.

The succeeding strakes are to be fitted on in a similar way, with the exception of the upper strake. This, of course, at its top part must have the same regular sweep as shown in the sheer draught. As the proper position of this line is given at each station in the sheer draught, no difficulty need be experienced; the proper point of intersection can be readily marked off on each of the wooden moulds on the mould-board.

A little difficulty may be experienced in fitting the plate round the swell for the propeller, and the sheet brass will have to be drawn slightly; the difficulty will be surmounted if a template of annealed brass is made to lie on the swell for the propeller in the same way that the vessel's plating will be required to lie.

The counter, which is made in one piece, may be given its concave form inside by using a number of templates of cardboard or thin tin plate, working the plate into its proper form, and using the dishing block and wooden mallet as before described.

The hull, after it has been neatly jointed up and all superfluous solder removed, may be lifted from the mould-board, the holes for propeller and for the rudder shank plugged up, and the hull floated. Any little defect may be rectified by soldering up on the inside. It should float perfectly upright and on an even keel ; if it does not, the instructions have not been thoroughly carried out, and the remedy is to trim with permanent ballast when placing the engines on board.

The building of the boiler will now be considered.

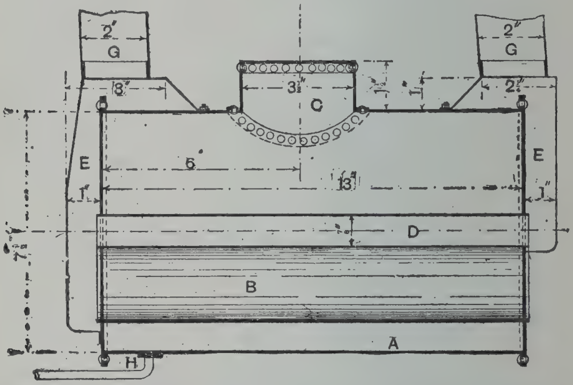


Fig. 95.—Longitudinal Section of Boiler of Model Liner.

Fig. 95 is a longitudinal section of the boiler, Fig. 96 is a half-sectional view of the back or after end, whilst Fig. 97 is a full elevation of the front or fore end.

The boiler has two furnace tubes, both of which extend from the fore end to the after end without interruption. As the boiler is to be heated by means of a blow-lamp, it is advisable that the flame should not meet with any obstacle for the full length of the furnace tube, in order to ensure better combustion and to give the back end of the boiler as much heat as possible.

The fuel to be used by the two lamps, for a boiler of this design, is benzoline under pressure. The temperature obtained is between 2,000° and 2,200° F., the flame being expelled from the nozzle of the lamp with some force, and it is thus not advisable to interrupt the course of this flame by using a bridge or other form of baffle, which might cause the flame to "flash back," and cause an explosion of the lamp.

By using two funnels, there is a freer exit for the hot air caused by the forced draught; part of the hot air only will ascend up the after funnel, whilst a like quantity will return along the smoke tubes and up the funnel leading from the smoke box at the fore end.

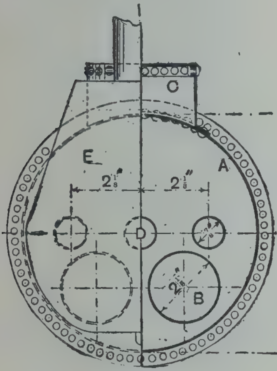


Fig. 96.

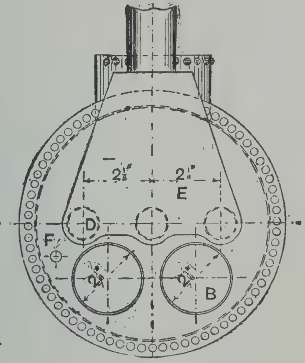


Fig. 97.

Fig. 96.—Half-sectional View of "After" End of Boiler.
Fig. 97.—Front Elevation of Boiler.

The shell A and furnace tubes B, as shown in Figs. 95 and 96 in section, are of solid drawn brass or preferably of No. 16 B.W.G. copper tube. The furnace tubes, however, may be a little thinner—say No. 17 B.W.G., or = ·056 in.; while the shell, end, and dome C are ·064 in. in thickness. The processes of brazing and flanging must be thoroughly performed, as the boiler is intended to carry a pressure of 45 lb. per square inch in order to drive the compound engines.

The capacity of the boiler, as a rule, should be four or five times as much as the water it boils off per hour, and the steam space should be at least ten times as large as the consumption of steam at each stroke.

The three illustrations of the boiler are, as will be seen, dimensioned in the main parts. Any other dimensions may easily be got by measuring the illustrations, which are drawn to the scale of 2 in. to the foot, or one-sixth full size.

The extreme length of the boiler, measuring from outside of flanges before end plates are riveted on, is 13 in., and the diameter inside is 7½ in. As the end plates are to be riveted to the ends of the boiler, allowance must be made for the two flanges when obtaining the material for the shell. The rivets should be ⅛ in. in diameter; therefore the width of the flange will require to be a little more than three times the diameter of the rivet; 7/16 in. must be allowed at each end for flanging, or altogether a tube 13⅞ in. long by 7½ in. inside diameter is required to form this part of the boiler shell.

The furnace tubes will be 13½ in. long by 2⅜ in. inside diameter. This extra length is allowed so that the ends may stand "proud" of the plate in order that they may be slightly expanded in their place, and afterwards brazed with silver solder to withstand the high pressure. This also applies to the smoke or return tubes D, which are to be ⅞ in. inside diameter.

The dome C (Fig. 95) is to fit accurately on the top of the boiler. It is 3½ in. inside diameter, and when finished will measure 1½ in. from the top of the boiler. This is not the length of the tube before the dome is made from it, but when flanged and fitted to its place. Therefore it will be necessary to grip a 4 in. length of tube in the vice, and file with a half-round file until it fits the top of the boiler, slipping it temporarily upon a wooden mandrel, in order that it may not be flattened whilst gripped in the vice. Flange the dome in the same manner as the ends of the boiler, allowing the same breadth of flange.

The holes for the rivets may then be pitched off and drilled, and the dome placed in position, as shown in Fig. 95. Having ascertained that the centre line of the dome is in line with the fore and aft centre line of the boiler, mark off two holes on each side of the dome for drilling the rivet holes in the boiler. These holes must be marked out with a steel scriber, through the holes already drilled in the dome. The rivets in every part of this boiler should be ⅛ in. in diameter, and they should be pitched at a distance of ⅜ in. from centre to centre of rivet. Whilst the drilling is progressing round the flange of the dome, bolts and nuts may be used to secure the dome in its place temporarily; they also help to get the holes in accurate relation to each other, an important factor in boiler-making. The holes for the cover of the dome may be formed either before it is placed in position for drilling the holes in the flange, or after, as it is obvious that the dome itself is not to be riveted on and brazed before its cover is made a permanent fixture.

The method of making the boiler mentioned above is briefly as follows:—After the shell of the boiler has been flanged, cut the hole for the dome; next build up the dome, and rivet and solder it with silver solder firmly to the boiler shell, using a blowpipe. Next, fix on either of the boiler ends, taking care that the centre line, running from side to side of boiler and through both furnace tubes, stands at right angles with the vertical centre line running down through the dome. Both furnace tubes and smoke tubes may be entered into their respective places in the plate or boiler end thus fixed. The opposite boiler end may then be placed in position and riveted up. Great care must be exercised in getting the last end plate of the boiler into position; some difficulty will probably be experienced in entering all five tubes into their holes in the plates. The furnace and smoke tubes may now be tapped through the two boiler ends until their ends stand "proud" to an equal distance, after which they may be expanded and brazed in. This latter operation is not, of course, to be done until it is ascertained that all rivets are sound and the ends are sweated up.

The two outside combustion chambers E, made of ordinary tin-plate for lightness, are shown in Figs. 95 to 97, and require little explanation further than that given in the drawings. The combustion chamber, properly speaking, is at the back end of the boiler, whilst that at the front end is the smoke-box; both are soldered below the water-line of the boiler and fixed by means of ⅛-in. studs and nuts above (see Fig. 95). The holes for these studs, after the latter have been screwed into the boiler, should be caulked to render them steam-tight, and if found not so when the boiler is tested under steam, they should be sweated in with silver solder, using the blow-pipe. The boiler mountings — including the force-pump for feeding (which must be worked by hand when fresh water is required for the boiler), safety-valve, water-gauge, and steam-tap or stop-valve—are bought more cheaply than they can be made by the amateur with his limited tools.

The spring safety-valve should blow off at a pressure of 45 lb. per square inch. It is, of course, only approximately shown in Fig. 98, which is a longitudinal section of the liner; it may lie in any convenient position on the dome, and, for neatness of appearance, should blow off its waste steam into the forward waste steam pipe.

The boiler should have a feed-check or back pressure valve at F (Fig. 97), and the pump should be fitted with suction and delivery-valve. The pipe below the suction-valve has open connection with the water outside.

The funnels G (Fig. 95) should be 2 in. diameter, and made of hard rolled sheet brass ·02 in. thick; they may be either round or oval. The bottom blow-off cock should be soldered to the ship's side, and the pipe H shown at the bottom of the boiler led to it. All piping, both for steam, exhaust, and blow-off, as well as feed and waste-steam pipes, should be $\frac{5}{16}$ in.

diameter. The length of the funnels is shown to scale, in Fig. 98.

Model marine screw engines are of many patterns, and opinions differ greatly as to the size and class of engine that should be put in a liner such as that under consideration.

The best, of course is the lightest as far as dead weight is concerned, provided that it is sufficiently strong for propelling. The engine may be lightened by substituting the usually heavy bed-plate for one made of hard rolled sheet brass $\frac{3}{32}$ in. thick; to this the feet of the back columns may be soldered and the feet of the front columns screwed.

Assuming that the castings of the engines have been obtained with cylinders and other castings bored and planed, little difficulty should be experienced in putting them together. The instructions on making model marine engines given in Chapters V. and VI. will be of help in this part of the work. It may be found cheaper to buy the castings from a regular model maker, and build the engines

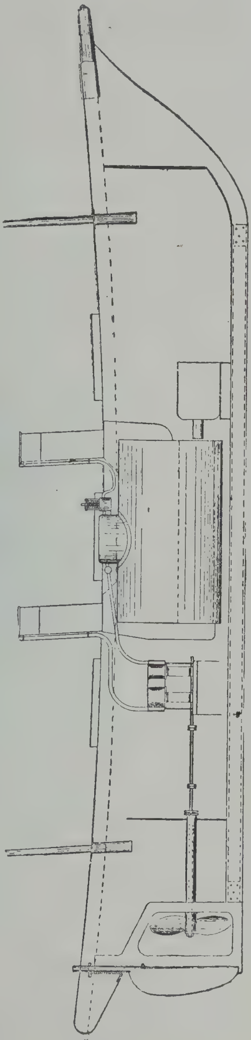


Fig. 98.—Section of Model Atlantic Liner.

to the working drawings supplied by him, with the help of the information just mentioned.

The engines and boiler having been constructed, and the two lamps having been bought, the vessel must be floated to determine by trial which is the best position to fix engines, boiler, and lamps so that the liner will float upon an even keel. By this is meant that she will be the same height from the water's edge at the extreme point forward as she is at the extreme point aft. Care must be taken that the hole for the propeller shaft has been carefully plugged up, so that the vessel will not fill with water. If the instructions for building the vessel's hull have been carried out, the boiler should, on trial, rest forward rather than immediately over the midship section. Placing the boiler in this position first of all, set the engines and lamp the distance from it shown in Fig. 98.

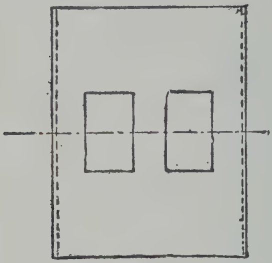


Fig. 99.—Plan of Engine Seating.

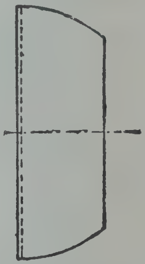


Fig. 100.—End Elevation of Engine Seating.

When the distances and positions of engines, boiler, and lamps have been properly determined by trial, and marked by fine chalk or pencil marks, the boat may be brought out of the water again and the seating for the engine, boiler, and lamps prepared. Figs. 99 and 100 are plan and end elevation of the engine seating. The seating for the lamp is constructed in a similar way. Of course, it does not require the apertures shown in plan in the engine seating, which are to admit of the crank-pins coming down below the engine seating. The seating for the lamps will be situated so that their nozzles play straight into the furnaces of the boiler; the correct height of the lamp seating is to be got, therefore, after the boiler has been permanently fixed in its seating. The engine seating is of $\frac{1}{16}$ in. hard-rolled brass sheet, and the rounded laps shown in the end elevation are made to fit the sides of the vessel's hull. It is to be carefully fitted in its position, which is controlled by the line of shaft, and is as nearly as possible parallel with the line of the keel.

Having fitted the engine seating to the boat, solder it neatly inside the hull, and place the engine bedplate immediately over and central with the keel, or, more correctly, with the middle line of the ship.

An important matter is to get the shaft line to lead direct fore and aft, so that the engine will run without unnecessary friction. It must be remembered that fully two-thirds of the power of a model marine engine is employed to overcome the friction of its own parts; care must be taken, therefore, to obviate unnecessary friction

It has been observed that the hole in the stern post, which is to receive the spigot end of the stern tube, is first of all to be bored out to $\frac{1}{16}$ in. smaller than the finished size of the stern tube spigot that is to fit this hole. The hole must now be reamed or otherwise bored out, and to do this, fix the bedplate, by means of through bolts and nuts, to the engine seating, which will have been made and fixed permanently to the vessel's hull by soldering the rounded laps shown in elevation (Fig. 100), the position of the seating being regulated by the line of shafting according to plan. The bedplate of the engine can be laid in line by passing a rod of steel or iron wire $\frac{5}{16}$ in. in diameter—which will be the diameter of the shaft—through the three bearings of the bedplate and leading it aft until its end comes in line with the hole for the stern tube in the stern post. When this has been done, the holding-down bolts for the bedplate may be put in and finally screwed up. A reamer is required whose shank is $\frac{5}{16}$ in. in diameter, and whose length over all extends from (say) 2 in. forward of the engine bedplate to between the stern and rudder posts. It is obvious that the reamer must be made of such diameter at its after end that it will ream out the hole in the stern post to the required diameter of the stern tube spigot.

After reaming out this hole, the spigot of the stern tube may be turned down to fit it, and the shaft itself tried in; or a piece of $\frac{5}{16}$-in. steel wire, which must be perfectly straight, may be employed to set the stern tube permanently in position. Pass the $\frac{5}{16}$-in. wire as before through the main bearing-brasses of the engines, in the same manner as when reaming out the hole for the stern tube spigot, that is, by taking off the top brasses and replacing them when the reamer, or, as in this case, the $\frac{5}{16}$-in. wire, is in line fore and aft. Now the stern tube is to be put in its place and the gland of the stern tube put on to the $\frac{5}{16}$-in. wire, and the wire passed through the stern tube and allowed to protrude into the propeller aperture.

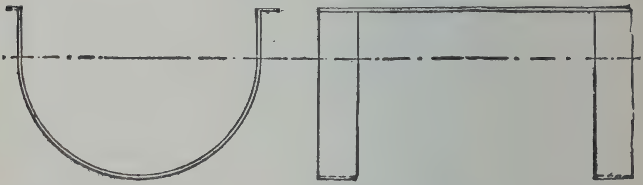


Fig. 101. Fig. 102.

Fig. 101.—Side Elevation of Boiler Seating; Fig. 102.—End Elevation of Boiler Seating.

If there is no unnecessary friction, the gland of the stern tube should slide along the $\frac{5}{16}$-in. wire into position in the stuffing-box of the stern tube. When the shaft is fixed in position the gland should be a free working fit without any shake. If it is not free, it is binding somewhere, or the shaft or rod is not in line.

After getting the stern tube in line with the fore and aft centre line of the engines, it may be fixed permanently, with two ⅛-in. screws, by means of a bulkhead, as shown in Fig. 98.

The method of preparing the seating for the boiler is shown in side elevation by Fig. 101, and end elevation by Fig. 102. The boiler lies, as it were, in slings, which are soldered to the bottom of the boiler. Fig. 103, which gives a midship section of the liner, shows the manner in which the boiler is fixed in position. The lugs on the ends of the slings lie on ledges soldered fore and aft inside the vessel's hull, one on either side, and at such a distance apart that the boiler will just pass between them and allow the lugs to rest upon these ledges, to which they may be made fast on the vessel's side by means of four through bolts and nuts ⅛ in. in diameter.

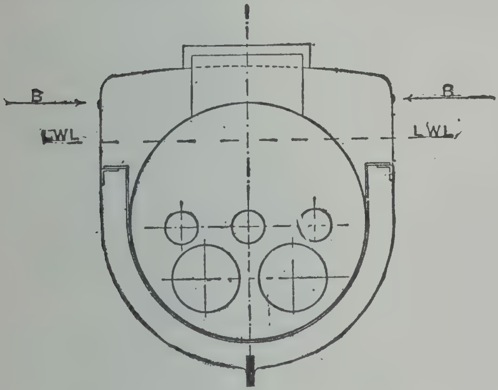


Fig. 103.—Midship Section of Boiler.

Having fixed the engines, boiler, and lamps on board, packed the stern tube and rudder trunk stuffing-boxes, and connected up the steam and exhaust pipes as shown in Fig. 98, the flush or spar deck may be built up. This is merely a high lid which covers the hull and machinery, and is soldered neatly to the hull at the line of beading, B, Fig. 103.

It will be found most convenient to build the flush deck of the vessel under consideration in three sections.

From Fig. 98 it may be seen that the model has three hatches—one over the lamps, one over the boiler, and one over the engines. These are placed in positions so that access may readily be got either to lamps, steam stop-valve or cock, or to the safety-valve and the engines—in the latter case for lubricating purposes. In case anything should go wrong, either in boiler- or engine-room, the deck immediately over this portion is fixed in such a manner that it can be removed for inspection without much trouble, and without injuring the hull. It will therefore be advisable, after fixing the fore and after portions of the deck, to place the amidships portion on last of all. The fore portion of the deck is to extend from the cut-water or bow of the vessel to immediately in front of the fore hatch; the after portion is to extend from the after end of the counter or stern end of the steamer to immediately aft of the after hatch. Thus the midship portion of the deck embraces the whole of the three hatches.

The form of the deck may be readily obtained from the sheer plans, which comprise the sheer draught of the steamer. Cardboard templates may be drawn and cut out to the curvature given. The deck is to be made of sheet brass, hard rolled, of the same thickness as the hull of the vessel. A slight swell or camber should run across the deck, to allow any water that may be dashed on deck in the shape of spray to run off again. If the deck were quite level it would appear to the eye to be dished. A graceful rise—say of about $\frac{3}{16}$ in.—will be found to give the vessel a more rakish and shipshape appearance.

The two holes necessary for allowing the two funnels and waste-steam pipes to protrude through the deck, are to be cut about $\frac{1}{4}$ in. larger in diameter than the funnels. The adjoining holes for the waste-steam pipes should have a similar clearance.

After the midship portion of the deck has been fitted on finally in the manner shown by the midship section, Fig. 103, two half-rings of $\frac{1}{16}$-in. sheet brass, $2\frac{1}{4}$ in. diameter, and $\frac{5}{8}$ in. breadth, may be soldered at the root of each funnel on the deck. They will, of course, require to be removed every time it is necessary to take off the midship part of the flush deck.

The fitting-in of the two masts and the bowsprit, as shown in Fig. 98, is now to be proceeded with. Two tubes are to be made, with a flange on one end soldered to the deck. The masts, which are to be made of pine, must be a driving fit in the tubes, and should measure $\frac{1}{2}$ in. diameter at the bottom end, tapering away to $\frac{1}{4}$ in. diameter at the top, underneath the truck, and their length from the deck is to be 24 in.

A similar tube is soldered underneath the deck at the fore end; this tube, which must of course be parallel and without a flange, is to receive the bowsprit, as shown, to which it must be a good fit. Should a small flagstaff be deemed necessary, it is to be fixed in a similar way to which the masts have been secured in the deck, as shown in Fig. 78, p. 78. The masts should be sandpapered smooth and clean, and a coating of oak varnish should be applied to them, the flagstaff and bowsprit receiving the same treatment.

The arrangement of the standing rigging may be readily understood from Fig. 78, p. 78. It consists principally of the stays running from the bowsprit to the foremast, and the standing rigging or shrouds extending from the four deadeyes to the masts on either side of each mast. The deadeyes are made of $\frac{1}{16}$-in. sheet brass $\frac{1}{4}$ in. diameter, soldered to the line of beading running all round the steamer. This represents in a manner the position of the "'tween deck." The masts have bands of sheet brass or brass tube with a small eye soldered on to take the miniature rope of shrouds and the foretopmast and other stays of the liner. These bands are also to be fitted to the bowsprit, as shown in Fig. 78, after which they may be painted black. Flag lines or halyards may be rove through the trucks and secured to cleats made from $\frac{1}{16}$-in. brass wire each flattened in the centre to take two small pins to secure them to their place at the foot of each mast on deck. The anchors and cable chain may be bought from any model maker. The chain is only for show purposes, and may be entirely dispensed with in the case of a racing model.

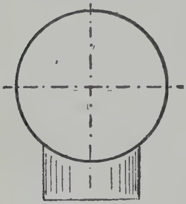


Fig. 104.

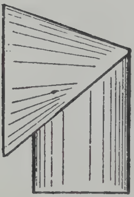


Fig. 105.

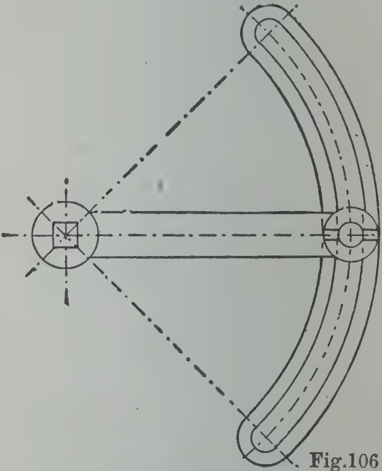


Fig.106

Fig. 104.—Front View of Ventilator; Fig. 105.—Side View of Ventilator; Fig. 106.—Plan of Steering Gear for Model Liner.

Before painting the model, place two ventilators, as shown in Figs. 104 and 105, under the bridge and aft of the fore-hatch; they may be made either of light copper or sheet brass. What has been left over after the deck has been made will be very suitable for this purpose. The ventilators supply air to the blow-lamps, and are to be soldered to the deck.

The arrangement for steering, or rather controlling the position of the rudder, is shown by the plan and elevation, Figs. 106 and 107. The rudder may be placed amidships or to port or starboard, as desired, and can be fixed in position by means of a clamping screw tightened up with the finger and thumb.

The propeller is to be 6 in. diameter and 9 in. pitch filed up bright, with the ahead-way edges as keen as a knife. The propeller is to be fitted in its place on the tail-end shaft, which must be tapered $\frac{1}{16}$ in. for nearly the full thickness of the propeller boss, and further secured by means of a $\frac{1}{4}$-in. nut, preferably of brass. The propeller is *not* to be painted.

A starting lever which is fitted to the steam tap on the after side of the dome must not protrude through the centre hatch, as this would give the ship the appearance of a toy and not of a proper model. When the engines are to be started or stopped, the hatch must be lifted or slid along.

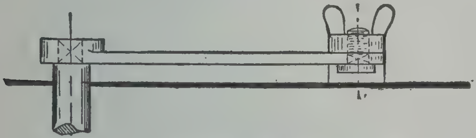


Fig. 107.—Elevation of Steering Gear.

The construction of the model being now complete, the painting can be proceeded with. Of course, the hull and deck must be free from oil or grease. The colours in which the model liner is to be painted must be a matter of individual taste. Here are a few suggestions: Give the hurricane deck and bridge two coats of white enamel from stem to stern, and from the beading on the starboard side to the beading on the port side. Apply to the hull, from the beading down to $\frac{3}{4}$ in. below the load water-line, two coats of black enamel-paint. The remainder of the hull below this may have two coats of salmon-coloured enamel. The hatches may either be coated with brown enamel or they may be painted and grained to represent wood. The lids of the hatches may either be made to shut down or to slide, as may be considered convenient.

Many models have their brass funnels polished bright, but this, of course, is not the fashion of an ordinary steamship. The best colour for the two funnels is buff, which is a mixture of white lead with a dash of yellow ochre. It is to be mixed up with sufficient boiled oil to moisten it, after which it can be thinned down to its proper consistency with paraffin oil, as it will have to stand the great heat thrown out from the furnaces. The tops of the funnels may be painted black with lampblack moistened with boiled linseed oil, and thinned with paraffin oil.

The outsides of the ventilators may be painted black, whilst the insides of their bell mouths may be coated with white or red enamel; or they may be polished bright. It is recommended that they should be painted, as then the whole vessel may be easily washed at times.

A steamship model such as that described in this chapter makes an effective ornament if placed within a well-made glass-sided case; the construction of a suitable case is dealt with in Chapter VII.

CHAPTER V.

VERTICAL ENGINE FOR A MODEL LAUNCH.

In this chapter it is proposed to give information on constructing a vertical engine suitable for driving a model launch.

The views given by Figs. 108, 109, and 110 represent the cylinder and its parts for a small but workmanlike model of a vertical engine of ¾ in. bore by 1⅜ in. stroke. The details of the construction of the engine will first be described, and then complete fully-dimensioned scale drawings of the model will be given.

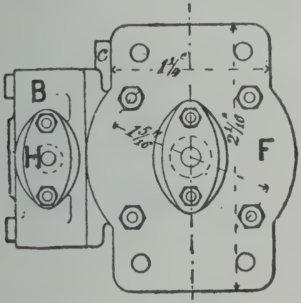


Fig. 108.—Bottom Plan of Engine Cylinder.

In the figures mentioned, A is the cylinder, B the steam chest, C the piston, D the slide valve, E the top cover, F the bottom cover, G the cylinder gland, H the steam chest gland. The minor reference letters will be referred to in due course.

The cylinder pattern (Figs. 111 and 112) will be the most troublesome to make. This cylinder is so small that it is scarcely necessary to turn the flanges, *a*, *a* (Fig. 109), separately from the body. It is, however, always better to do so, because when turned solid the grain is short and weak, and apt to be broken. When the flanges are turned separately, the usual and best practice is to recess the body of the pattern as at *a* (Figs. 111 and 112), plane the stuff for the flanges to the thickness *b*, cut out the holes to fit the groove at *a*, glue the flanges in, and when dry, turn them in place. These flanges, like the body, should be jointed longitudinally through the centre, x x, for parting in the mould.

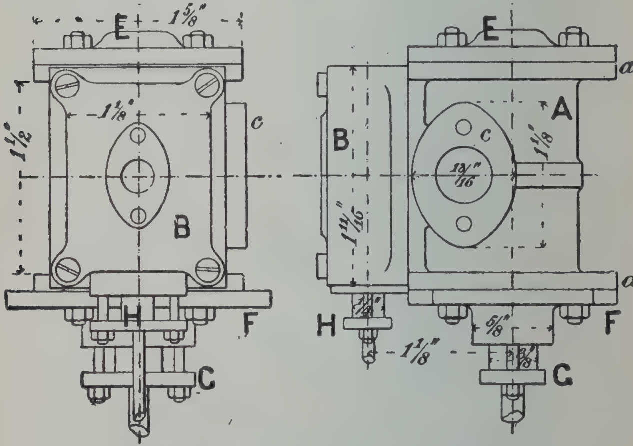


Fig. 109.—Elevations of Engine Cylinder.

Note that the prints, A, A (Figs. 111 and 112), are parallel, the pattern moulding horizontally, and that ⅛ in. allowance is made for boring. Fit the steam passage block, B, to dimensions corresponding with *b* in Fig. 110, and on this dowel the steam chest facing C, which it will be observed carries the prints *c*, *d*, *e*, for the three passage cores. These prints are a trifle less in width than the finished ports, in order to allow of the port openings being cleaned out and filed square and parallel for precise cutting off of the steam by the slide valve. The finished ports are $\frac{3}{32}$ in.

The exhaust branch D, *c* in Fig. 109, made gland-shaped, will not deliver from the sand if the pattern is made precisely like the casting. It is necessary, therefore, to put a core over the half of the branch that lies between the centre line and the central joint of the pattern. Figs. 111 and 112, E, show this print, also the lower half, D, of the branch, and the half print, *e′*, belonging to it; this half print forms the complement of a half print, F, in the core-box, that is made for print E, to carry the exhaust port core.

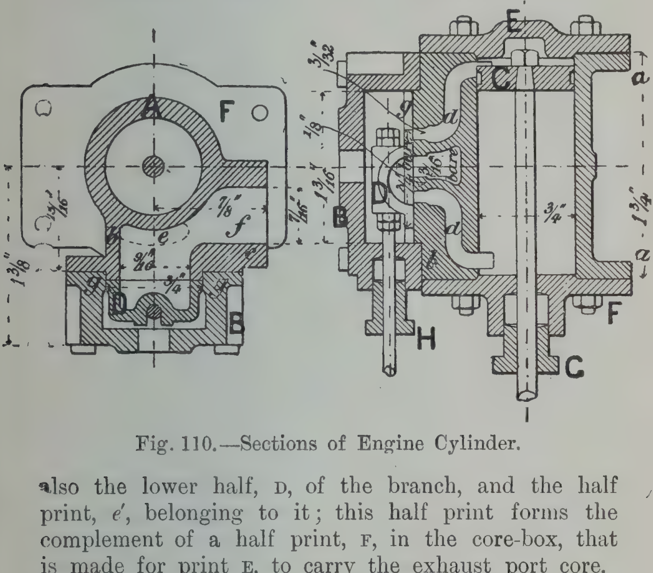


Fig. 110.—Sections of Engine Cylinder.

A core-box for the steam passages, one for the exhaust passage, and one for the core over the branch are wanted. No box is wanted for the central hole, because plain round core-boxes of various diameters are kept in all foundries.

The box for the steam passages is made in two portions dowelled together (Fig. 113). Its plan section is that seen in Fig. 110, *d*, plus the print thickness, *e d* (Figs. 111 and 112), and its cross section is the same as that shown dotted at *e* (Fig. 110). Shoulder back and dowel the box together first, mark the curved outlines on the faces, and work the sectional curves to templet. The sweep at the end opposite to the print end fits the body core.

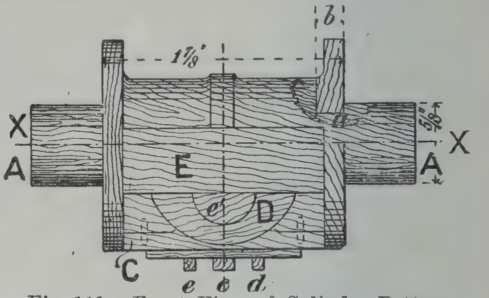


Fig. 111.—Front View of Cylinder Pattern.

The exhaust passage core-box, one half of which is open in Fig. 114, is in two portions, dowelled, then marked in the joint face to the outline of Fig. 110, *f*, plus the print lengths at *c* and *e′* (Figs. 111 and 112). The sections correspond with those on the sectional views (Fig. 108, 109, and 110), and are worked with templet.

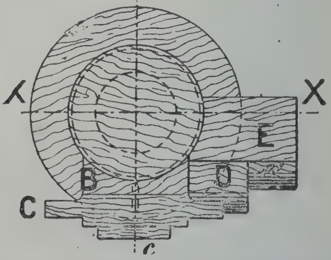


Fig. 112.—End View of Cylinder Pattern.

Fig. 115 shows the box for the branch core. Two sides, A, and two ends, B, are shouldered together and placed upon a bottom board C, and kept in one position by means of steady blocks, D, D, nailed on C. Upon the board, C, is glued the half branch piece, E, and half print, F, corresponding with D and *e′* in Figs. 111 and

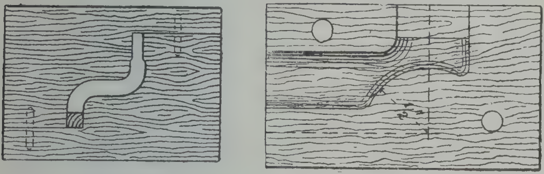


Fig. 113. Fig. 114.

Fig. 113.—Steam Passage Core-box; Fig. 114.—Exhaust Core-box.

112. When, therefore, the core made from this box is put in the impression made by the print E (Figs. 111 and 112), it is clear that a half branch and half print precisely like that left by the portion D *e′* of the pattern will be formed in the mould. In these

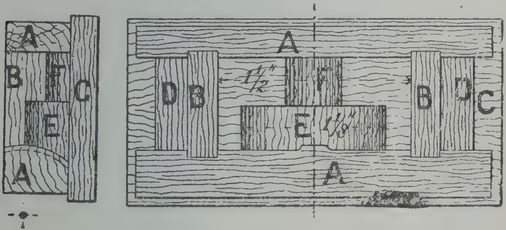


Fig. 115.—Branch Core-box.

print impressions the round end of the exhaust core, half of whose box is shown in Fig. 114, will be laid, the other end lying in the impression made by the print *c* (Figs. 111 and 112) in the bottom of the mould.

Useless castings will result if the core-boxes are not accurate, because the thin metal between the passages will be reduced. No moulder will undertake a job of this kind unless pattern and boxes are accurate.

The work of moulding these cylinders is not described, as few amateurs would care to attempt so fine a task. It is best to leave the making of these castings in the hands of the professional moulder.

In fitting the cylinder, great accuracy is the main point to be observed, the mechanical processes not being difficult in themselves. The worker is assumed to have the use of a lathe (as the work consists largely of turning), and of files, drills, and screw plate and taps.

The first operation is that of boring and facing the cylinder. A good method of doing this is to chuck the casting by one flange in a jaw chuck, and take one cut off the other flange. Take a rough cut out of the cylinder with a flat drill. Finish with a slide-rest cutting tool, or with another bit of correct diameter. Nothing more should be done to the bore; emery should not be used. Remove the cylinder, drive it over a mandrel of hard wood or of metal, and take a light finishing cut off each flange, to leave them perfectly true with the bore.

The valve and steam chest face on the cylinder must now be prepared. If a shaper or a lathe-planing attachment is not possessed use the file, first on the valve face and then on the steam chest face. The length and width of the shouldered portion need not be very exact, so that the steam chest is made to fit around it. Suitable dimensions—$1\frac{3}{16}$ in. by $\frac{3}{4}$ in.—are given in Figs. 108, 109, and 110. These faces should be level, and parallel with the bore, or the valve will work tight and slack alternately. The parallelism is tested by measurement between a straight-edge laid down the valve face and a mandrel projecting through the bore.

The port openings are now cleaned out with the file quite parallel, otherwise the steam will not be cut off sharp; the distances between steam and exhaust and the width of the two steam ports should be alike.

The steam ports finish to $\frac{3}{32}$ in., and the exhaust finishes to bare $\frac{3}{16}$ in., and the breadth of the bar is $\frac{1}{8}$ in. It may be necessary, in order to obtain true edges, to make the ports a little wider than the dimensions given, but the travel of the valve and the throw of the eccentric will then have to be proportionately increased.

The face of the steam chest casting is then filed true, and its inner edges made to fit the shoulder of the valve face. The inside strips, *g*, *g* (Fig. 110), must be made parallel and true for the edges of the valve to bear against. The valve must fit closely but freely here, and the length of the valve must be made to suit the port openings. For the ports shown in the figure the correct length is a bare $\frac{3}{4}$ in., but the rule that regulates the length of the valve will be explained when describing the eccentric later. File the recess in the back of the valve casting to receive the valve rod. The rod itself will be shown complete later.

The cylinder covers, E and F (Fig. 109), are turned all over. They have to fit into the bell-mouthed ends of the cylinder, and make perfect contact with the cylinder flanges. The other parts are turned, for good appearance chiefly. The turning may be done in a jaw chuck or in a chuck of hard wood, and presents no special difficulty; neither do the turning and drilling of the glands, G and H (Fig. 109).

Set screws, or preferably studs, may be used in fitting together the parts. Cut off some $\frac{1}{8}$-in. steel wire screws into suitable lengths. Drill holes in the cylinder flanges and steam chest face, in the positions illustrated, tap them, and screw in the studs tightly, allowing them to project far enough through the covers to receive the nuts over the covers. Studs or cheese-headed screws may be used for the steam chest.

The piston, C (Fig. 110), is solid brass, turned to fit the cylinder closely, yet freely. The recess shown is not for a spring ring in so small an engine, but to receive a bit of greased tow which is bound tightly around to prevent escape of steam at the sides.

All dimensions which are not mentioned in the text can be measured from the illustrations, which are strictly to scale.

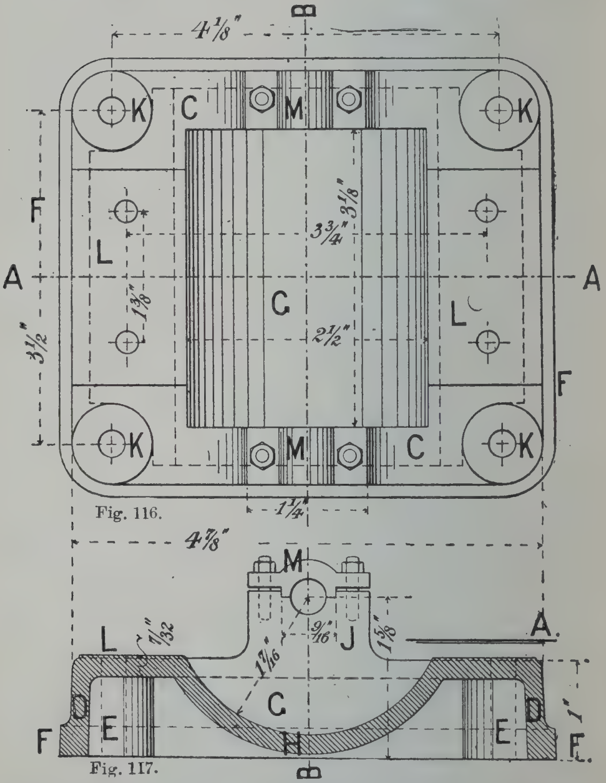


Fig. 116.

Fig. 117.

Fig. 116.—Base-plate of Model Engine; Fig. 117.—Section on Line A A.

The base-plate of the engine is shown by Figs. 116, 117, and 118. To make this, cut a piece of dry pine or mahogany to the size of the top, C; this is $4\frac{7}{8}$ in. by $4\frac{5}{16}$ in. by $\frac{3}{16}$ in. Glue vertical ribs, or flanges, D, $\frac{13}{16}$ in. deep by $\frac{3}{16}$ in. thick, round the edges of C, as shown. These stand at a slight angle with the plate to give taper for delivery from the sand; they may stand, say $\frac{1}{16}$ in. out of square. The ends of the flanges will merely be made to abut, and angle pieces will be glued in the corners to form the bosses, E, through which the hold-down bolts pass. When set dry and hard, the outer curves on the corners will be cut; this detail is shown at E in

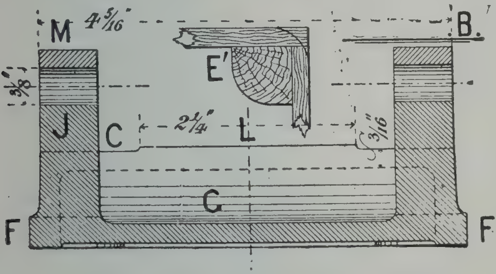


Fig. 118.—Section on Line B B.

the lower portion of the figure. The narrow fillets, F, will be planed separately as strips, and glued all round. The curved portions of the fillets that pass round the corners will be fitted as separate short bits with gouge and chisel, the straight lengths at the sides abutting against these.

The recessed portion, G, in the centre of the base is made thus to permit the connecting-rod end to clear. To make it, cut out the hole in the thickness of the plate C. Then prepare a sweeped piece, H, and glue underneath C, and fill up the ends of the sweeped piece with two planed strips laid and glued against them.

Two bearing blocks, J, J, are cut in wood and glued on the plate. Their bearings, being very small may be left uncut or solid, and be bored out of solid metal after the caps, M, are fitted and bolted on.

Four facing bosses, K, K, K, K, are glued on at the corners, to take the hold-down bolts. This is better than having outside lugs, which are liable to become snapped off when tightening the hold-down bolts, unless a very perfect bedding is obtained. K and E are, of course, placed at exactly the same centres: viz., 4⅛ in. by 3½ in. There are two facing pieces, L, L, cast on to receive the feet of the standards. A little pattern is made for the caps, M, to be cast in gun-metal. The hole is not cut in this.

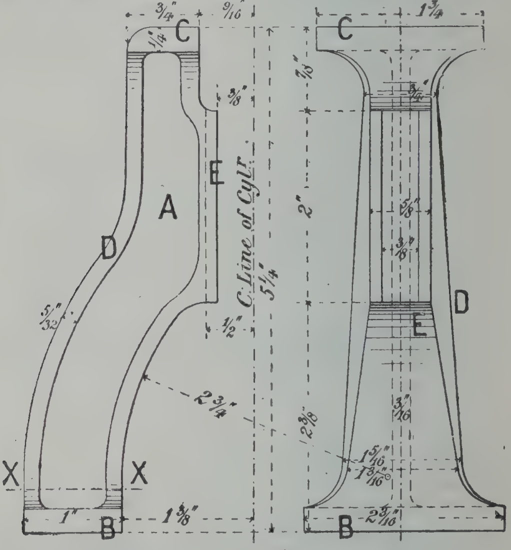


Fig. 119. Fig. 120.

Figs. 119 and 120.—Front and Side Elevations of Engine Standard Pattern.

The base-plate casting of iron is filed true on the bottom, and all the facings, K, K, K, K, L, L, are filed parallel with the bottom. Holes, ¼ in. diameter, are drilled through K and E for the hold-down bolts, and also in the facings L, for the bolts that secure the feet of the standards to the base. The caps, M, are shouldered by filing into the plummer blocks, J, and bolted down with studs; the centres of the bearings marked out and drilled. It is important that these centres are at an equal and parallel height above the base. It is also equally important that they are correctly set cross-wise—that is, parallel with the edges of the base in one direction, and at right angles with the other edges. If these points are not attended to, the crank will not work freely.

To make the standard pattern (shown in front and side elevation by Figs. 119 and 120), prepare a piece of $\frac{1}{8}$ in. stuff, large enough to cut the outline of the plate, A, given in Fig. 119, minus the thicknesses of the foot, B, and top, C. The ribs and feet and top are put on this in sections. The foot, B, is planed up, and squared to a length of $2\frac{3}{16}$ in. and width of 1 in., and thickness of $\frac{5}{16}$ in., to allow a little for facing, and nailed on the bottom end of A. The top, C, prepared to $1\frac{3}{4}$ in. by $\frac{3}{4}$ in. by $\frac{5}{16}$ in., is nailed on the top end of A.

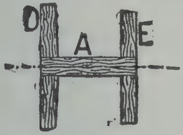


Fig. 121.—Section on Line X X.

The ribs, D and E, are formed of four separate pieces of wood, two being placed on each side of A; Fig. 121 shows a section of the pattern. The ribs have an inside taper of not less than $\frac{1}{16}$ in.; the outside is square for convenience of moulding.

The recess on the inner face of the straight portion of E in which the cross-head will slide, is not cast in, but filed subsequently.

As regards fitting the standard, the faced portions of the standards are the foot, B, and the top flange, C, and the guides, N E, for the cross-head. These faces are respectively parallel and at right angles

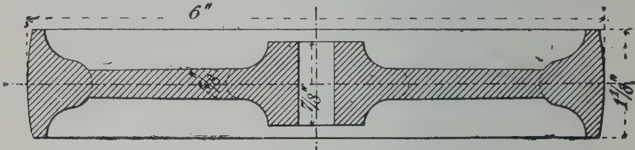


Fig. 123.

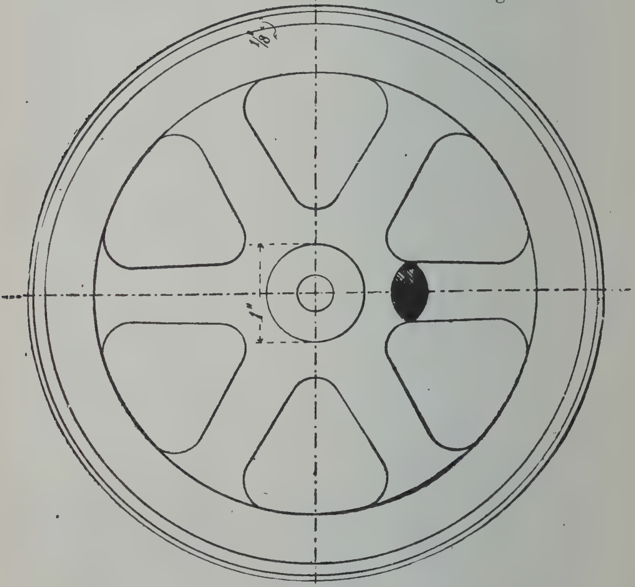


Fig. 122.

Fig. 122.—Plan of Fly-wheel ; Fig. 123.—Section of Fly-wheel.

with each other, and the edge of the groove in E must be quite parallel.

It is quite possible to cut the pattern of the fly-wheel out of solid wood if the stuff is perfectly dry and the mould taken from it at once, but a pattern-maker never adopts such a method. Fig. 122 gives a plan, and Fig. 123 a section of the fly-wheel.

The rims of fly-wheel patterns, in common with those of wheels of other kinds, are invariably built up in courses of segments. Sweeps, or segments, of dry wood are prepared, four, six, or eight to the circle, and glued over one another, with their end joints alternating in each successive set. This makes a rim that cannot go out of truth or become fractured by fair usage.

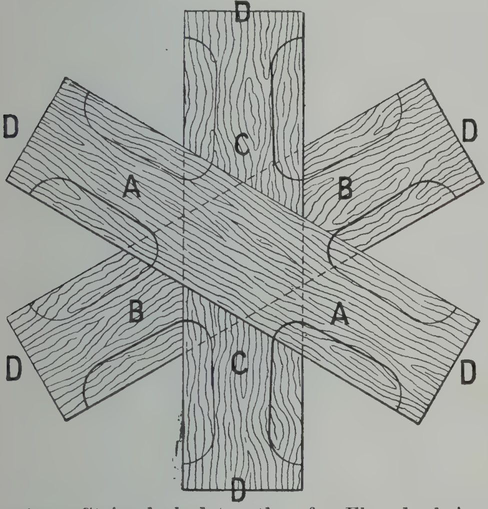


Fig. 124.—Strips locked together for Fly-wheel Arms.

The arms, too, instead of being cut from solid wood, are framed in three strips, locked together about the centre with rebated joints. Fig. 124 shows the strips framed and marked out in readiness for cutting to outline. Two-thirds of the total arm thickness is gauged and cut out from the outer faces of the pieces A and B, and one-third from each face of

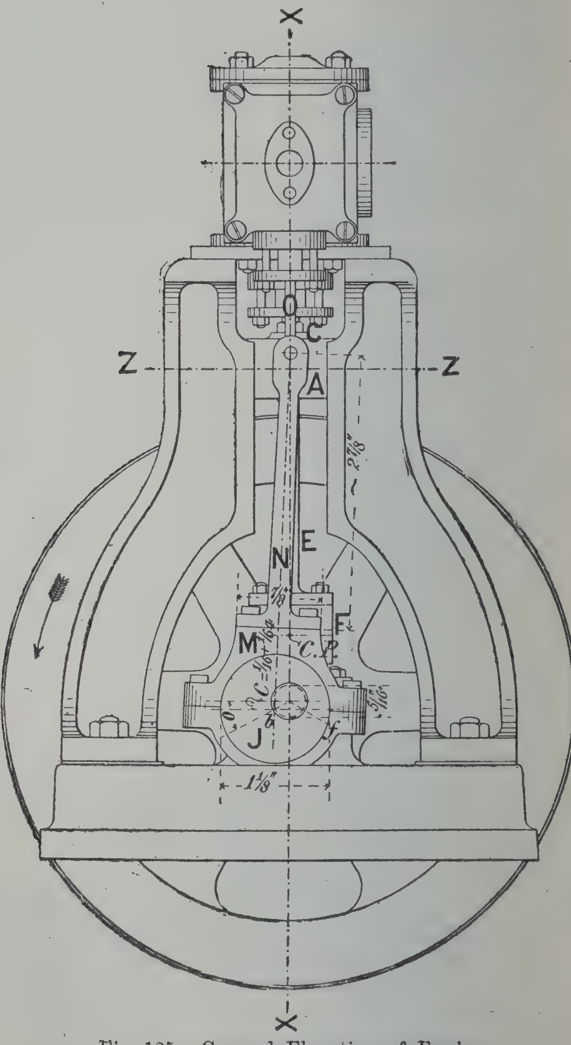


Fig. 125.—General Elevation of Engine.

the piece C. The flanking edges of the rebated portions are at an angle of 60° with the edges of the arms.

The ends, D, of the arms are built well into the rim, when the latter is glued up about half-way, and the remaining upper segments are built over them; or they are let in a little way only, after the rim is finished. The rounding edges of the elliptical section, and the curves that merge into the centre boss and the rim, are worked with gouge and penknife. Two bosses, glued one on each face of the arms, complete the pattern. The central hole, being small, is not cored, but is drilled through the solid metal.

The periphery of the fly-wheel casting and the edges of the rim are turned, and the bosses faced. The wheel when turned should, if freely suspended and revolved, show no tendency to come to rest with one particular portion lowermost. If there is such a tendency, some metal must be removed from that lowermost portion by filing inside the rim.

The construction of the main portions of the engine having now been described, the less important parts can be briefly noticed.

Fig. 125 is an outside elevation viewed from the side on which the steam-pipe enters the steam-chest, but with the outside crank bearing removed in order to show the setting of the eccentric. Fig. 126 is a part vertical section, taken at a right angle to Fig. 125, showing the cylinder and valve, the eccentric and sheave, the lower part of the base-plate, and the fly-wheel, in section, but with the cross-head, eccentric rod, crank, and crank bearings in outside view. Fig. 127 is a vertical section at a right angle with Fig. 126; and Fig. 128 is a horizontal cross section taken through the centre of the cross-head on the plane Z Z.

The fitting of the cylinder has been described. Tracing the cylinder connections to the crank. the following are found.

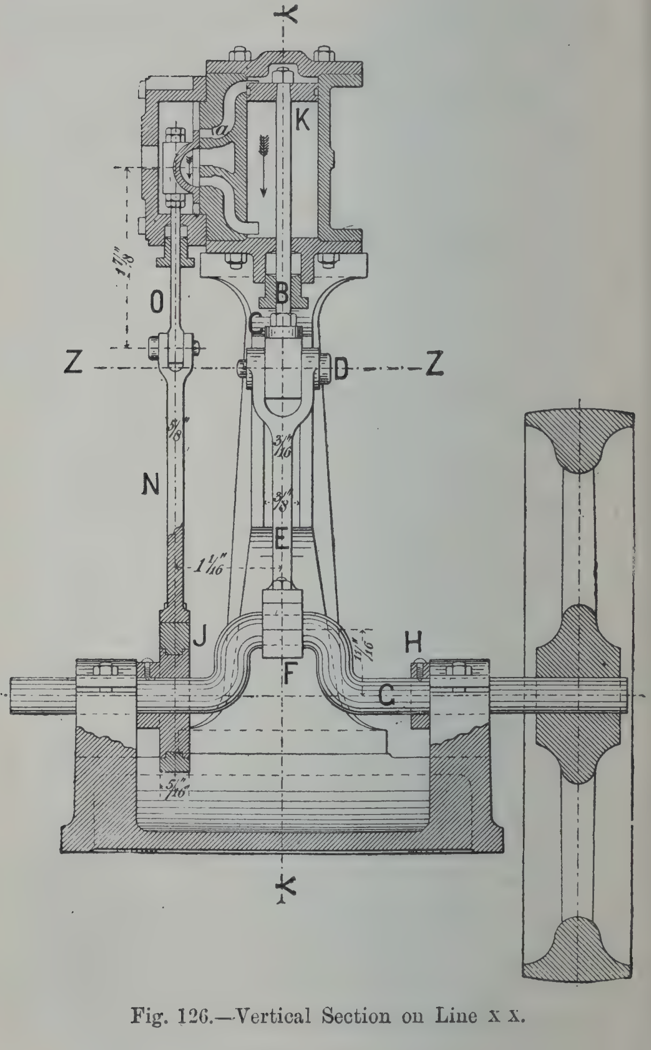


Fig. 126.—Vertical Section on Line x x.

The cross-head, A (Figs. 125-128), is either a gun-metal casting or a forging. It is a rectangular block with a bossed end, into which the end of the piston-rod, B, is screwed, and held secure with a lock-nut, C. A hole is drilled through the cross-head to take the connecting-rod pin, D.

The connecting-rod, E, is a steel forging, forked sufficiently to embrace the cross-head and to pivot freely upon it. At the other end the rod is flattened to take the crank pin brasses, F, F, which are bolted through the flattened expansion of the rod.

The dip crank, G, is of forged iron or steel. Being bent, the grain fibre is continuous, and it is therefore less liable to fracture than one which is slotted out of the solid. Be careful when turning this that the throw of the crank is exactly half the piston-stroke—$\frac{11}{16}$ in., as figured.

The collar, H, on the crank-shaft is to prevent endlong sliding of the shaft in one direction. The boss on the eccentric sheave, J, prevents movement in the other direction.

The setting of the eccentric is a task that offers some slight difficulty to amateurs. Unless set very exactly, it does not cut off the steam at proper times.

Note the relative positions of the slide-valve and eccentric, and of the crank-pin in the drawings. The crank-pin (that part enclosed by the brasses, F) is on dead centres nearest the cylinder; the piston, K, is at the top end of the cylinder, just on the point of moving downwards, and the slide-valve has opened the corresponding port, *a*, very slightly to steam. The centre, *b*, of the eccentric sheave, J, is past the horizontal centre of the shaft by the distance, *c*, or by the angle, O, from the shaft. These relations are all mutual and interdependent.

The minute distance, $\frac{1}{64}$ in. in this instance, by which the valve has opened the port, *a*, is called the lead of the valve. The crank, therefore, being on dead centres, a certain quantity of steam, or as much as can

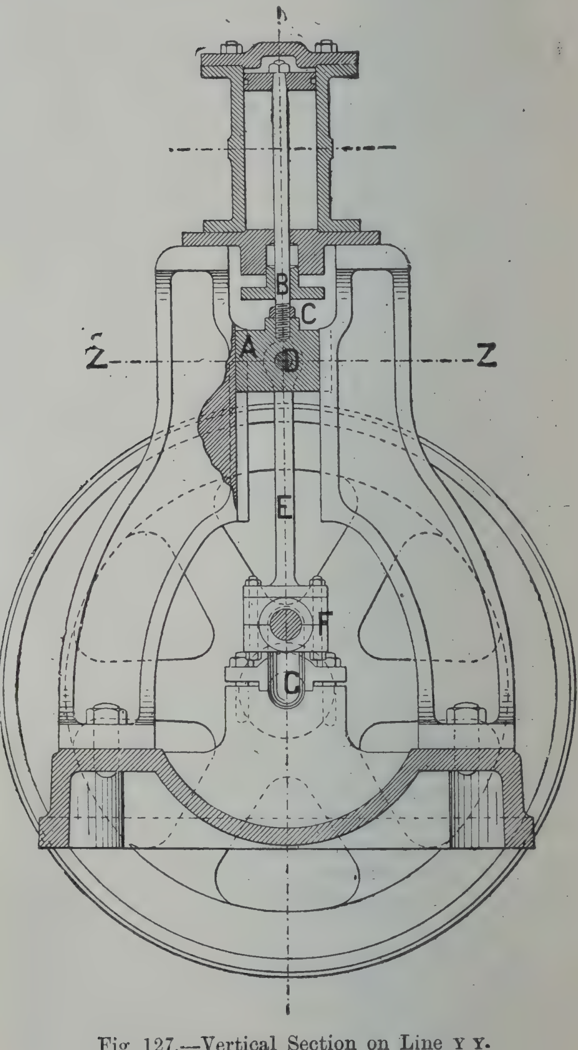


Fig. 127.—Vertical Section on Line Y Y.

pass into the port through the narrow slit opened by lead, is already in the cylinder before the piston commences to move downwards — that is, this steam was in the cylinder before the piston had quite finished travelling from below upwards. This steam, therefore, has acted as a cushion or buffer, bringing the piston gently to rest before the commencement of the return stroke. The distance, *c*, by which the centre of the eccentric is set in advance of the centre of the crankshaft is equal to the amount of the lead plus the lap of the valve. The lap is the amount by which the valve covers over the outer edges of the ports when in middle travel. Its purpose is to shut off the steam from the port before the piston has reached the end of its travel. The steam, cut off and imprisoned, then acts expansively.

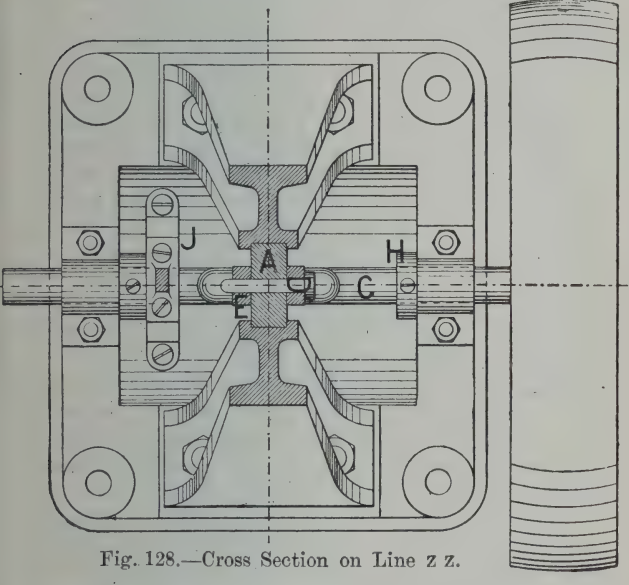


Fig. 128.—Cross Section on Line z z.

As the piston is about to descend, the valve must needs open in the direction of its arrow, and therefore the eccentric is set forward, as shown, by an amount equal to *c*, equal to the amount of lap plus lead, forming an angle of advance, O, 90° beyond the centre of the crank-pin. If the port is fully opened to steam, port opening, lap, and lead, must be added together to get the throw of the eccentric, equal its radius. The port opening is bare $\frac{3}{32}$ in., and the lap $\frac{1}{16}$ in., and the lead $\frac{1}{64}$ in., so that the throw is $\frac{11}{64}$ in. or $\frac{5\frac{1}{2}}{32}$ in. Hence the circle, $\frac{11}{32}$ in. in diameter, is the path of the eccentric sheave. The total distance across the extreme edges of the ports should be $\frac{19}{32}$ in., or $\frac{1}{2}$ in. and $\frac{3}{32}$ in. The length of the valve will be barely $\frac{3}{4}$ in. The opening to lead must be the same when the crank-pin is on opposite dead centres. The minute dimensions given above are not easily worked to, but accurate adjustment can be made before the steam-chest cover is finally screwed on.

As the eccentric is shown, it leads the crank and fly-wheel in the direction of the arrow. If the engine is required to run the other way, the eccentric must be set over on the line *f*.

If the port openings are made wider than bare $\frac{3}{32}$ in., the radius of the eccentric sheave must be made correspondingly longer; but an eccentric with a lot of throw looks unsightly, and the less travel given to a valve the better.

The eccentric sheave, J, is made of iron or of gun-metal, and the straps, M, of either material. The straps are shouldered over the sheave, as seen in Fig. 126, to prevent them from side slip. The eccentric rod, N, is a steel forging, fitted with a flat expansion to the top strap at one end, and with a fork at the other end to the valve-rod, O.

Provided that all its parts have been accurately fitted together, the engine is ready to be placed in the model boat.

As these drawings are made to scale, engines of any other size can be constructed from them.

CHAPTER VI.

MODEL LAUNCH ENGINE WITH REVERSING GEAR.

THE construction of a slightly different type of model launch engine will now be described, and from the description much can be omitted, as the instructions given in the last chapter on certain points will apply in this case also.

Fig. 129 represents the model of a launch engine fitted with reversing gear, the view being an outside elevation taken from the feed-pipe flange on the steam-chest cover. A good view of the link motion is shown, and the setting of the eccentric indicated; the latter is outside the crank-shaft bearings. Fig. 129 also gives a good view of the columns, and shows the double-flanged bracket, which acts as a slide-valve spindle guide. A turned flange is fastened on the steam-chest cover for the feed-pipe; this is drilled and tapped to suit $\frac{3}{8}$ in. pipe, a similar flange being used to carry away the exhaust steam.

The details of patterns of the cylinder and parts have already been fully described, so it is unnecessary to make further reference to them. Assuming that a model similar to Fig. 129 is to be made, proceed exactly as with the engine formerly described, using the same castings with the addition of another eccentric and strap for reversing gear.

In fitting, start with the cylinder. On the accuracy of the work depends the success of the model. The use of a lathe will be found indispensable; small chisels, files, screw-plates from $\frac{1}{16}$ in. up to $\frac{1}{4}$ in., and taps to correspond, will also be required.

The simplest and easiest way to bore the cylinder is to take a rough cut out of the casting, either on a drilling machine or in a lathe; the cut will follow the

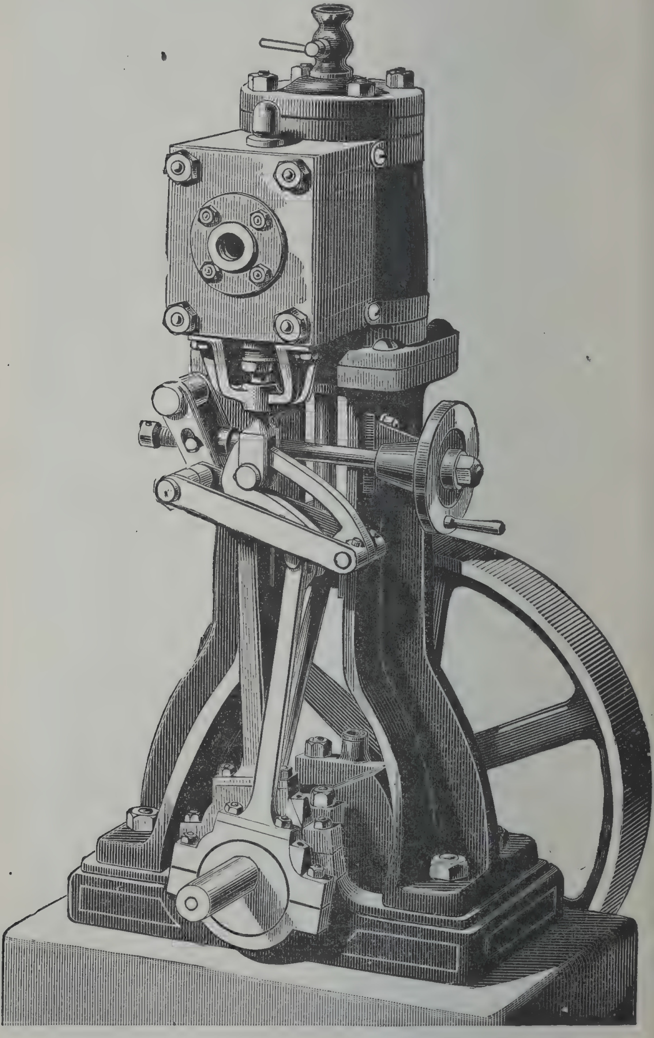


Fig. 129.—Model Launch Engine with Reversing Gear.

core in cylinder, and so will not be far out of truth. Then take a rose-bit the exact bore required—in this case 1½ in.—and run it slowly through to smooth the surface of the cylinder. Of course, this can be done in the lathe; but this is a difficult job for an inexperienced hand.

Drive the cylinder on a mandrel of metal in preference to one of wood, take a light cut off each flange, and polish the rims, which will now be quite true to the bore. To surface the port face, if a shaping or planing machine is not possessed, take off a light chipping with a small straight-cut chisel, so as to remove the scale, and then file the face down to lie flat upon a surface-plate, which can easily be made out of a bit of cast iron about 6 in. by 9 in. by 1 in.; this is a convenient size for all sorts of small work. The surface-plate is of help in getting the valves dead true and in setting out different parts of a model engine, care being taken not to damage the surface of the plate. When the port face touches fairly all over, ease off by scraping the places where it touches hard on the plate. To make a scraper, grind all the teeth out of an old flat file (this will prevent it splitting when heated for drawing out), draw it out at the end, harden it in water, and finish by grinding square. Use an oilstone to give a keener edge and take off the burr caused by grinding. The length and width should be filed to suit steam-chest, though this is not very important. The port face in cylinder must be true to the bore, or the slide-valve will bind at one part of the stroke and work loose at another. This can be tested by putting a straight-edge along the port face, and by having a centre in each end of cylinder, or by replacing the mandrel and trying the distance between the centres and the straight-edge.

The steam and exhaust ports should now be squared out parallel to each other, and all exactly at right angles to the bore; otherwise the steam will have an unequal and slow cut off. It is far better to have the cylinder face cast solid, and to have the ports and exhaust drilled out. To mark these out, place the cylinder on either of its turned flanges on the surface-plate, or any flat surface. Take the scribing-block, and draw a line across the centre of cylinder, and, with a pair of compasses, from the centre line mark off distances for ports; drill four $\frac{3}{16}$ in. holes at each end, and two $\frac{3}{8}$ in. holes in centre for the exhaust. These should be drilled far enough in to meet holes in valve face; between exhaust and steam and two steam ports the distance should be the same. The steam ports finish to $\frac{3}{16}$ in., the exhaust $\frac{3}{8}$ in.; breadth of bar is $\frac{3}{16}$ in., travel of the valve, $\frac{3}{8}$ in.

The slide-valve is $1\frac{3}{16}$ in. long by $1\frac{1}{8}$ in., and the exhaust is cut out $\frac{3}{4}$ in. wide. File the slot in the back of valve to suit the slide-valve spindle, which is $\frac{3}{16}$ in. in diameter and $3\frac{1}{2}$ in. long from centre of joint hole to end of spindle. The end of spindle is forked to receive the die for reversing gear and eccentric-rod end for ordinary valve gear; the other end is threaded $1\frac{3}{4}$ in. to take $\frac{3}{16}$ in. nuts, for holding the valve in place when it is set. The forked joint must be hardened.

The top cylinder cover is turned all over, and polished on the face after being let in to the top end of cylinder; this is easily held in a jaw chuck or by means of a mandrel put through the hole for the lubricator.

The bottom cover is a piece of cast iron $\frac{5}{16}$ in. thick with a boss standing up $\frac{3}{8}$ in. for piston-gland. Length of cover is $3\frac{1}{8}$ in.; width at centre, $2\frac{3}{4}$ in.; across the ends, $2\frac{3}{8}$ in. Drill a hole to suit piston, which in this case is a $\frac{5}{16}$ in. rod; drive in the mandrel, and after letting the cover in cylinder, open out gland hole with $\frac{1}{2}$ in. drill $\frac{3}{8}$ in. deep.

In fitting parts together, it is workmanlike to use studs and bolts instead of screws, as the nuts form a good set-off to the covers—screw-plates suiting sizes required for the cylinder, $\frac{3}{16}$ in. Take a piece of $\frac{3}{16}$ in. steel wire and thread about 6 in. or 8 in., then cut off pieces the right length to suit. Drill the covers and steam-chest top and bottom to the tracing, and mark the cylinder from the covers. By this means the holes will be got true, otherwise they may have to be slotted, and this looks very bad; tap the holes in cylinder and screw the studs in tight to the right length.

The piston is a solid piece of cast iron, turned to fit the cylinder and recessed in the centre to take a piece of greased tow or lamp cotton rolled tightly round it. This prevents the steam getting by during the stroke.

The base-plate casting should be planed, or, if convenient, shaped on the bottom, the remaining faces being then planed or filed true to the first. Two bolt-holes are drilled under the centre of the column through the bed to hold it in its place when finished. The bearings are filed to receive the brasses; the caps are made to suit, and are fixed and held in their places by $\frac{3}{16}$ in. studs. Place the bed on a flat surface, and mark with scribing-block the centres of brasses; these can be taken out and drilled separately. This is far easier than having them drilled while in the brackets. Then replace and carefully bed to the crank; otherwise the brasses are likely to run hot when working.

The planed or faced surfaces of the columns are those at the top and bottom and the cross-head slide. In the first place, get the cross-head slide planed or filed; then have the two flanges, top and bottom, planed at right angles to it; this can easily be done by using a square.

The brass or cast-iron cross-head is a square block, with boss on the top end to receive the piston-rod, drilled in the centre of the block to receive the gudgeon, which is $\frac{1}{4}$ in. in diameter and cast hollow for small end of connecting-rod to fit in.

The connecting-rod is of forged steel, the small end being an eye-joint to fit in the recess cast in the cross-head to receive the gudgeon. The large or crank end is flattened to take the crank-pin bearing, which is bolted to connecting-rod with $\frac{3}{16}$ in. bolts. These bolts have round pin heads, having small keys under the head let into the flat end of connecting-rod to prevent them turning whilst being tightened up.

The crank-shaft is built up, and is a balance weight crank composed of five pieces. It is more easily made thus than if it were in one piece; but care is required to get the parts accurate. Two pieces of $\frac{9}{16}$ in. round steel, 3 in. long, are each threaded $\frac{1}{2}$ in. diameter for $\frac{3}{8}$ in. at one end, a collar being left to butt against the slab. The slabs are two pieces, 3 in. over all, by $\frac{3}{8}$ in. thick. The width at the pin end is $\frac{7}{8}$ in. as far as the centre of the crank, thence it tapers out to $1\frac{7}{8}$ in. The ends, when finished, with eccentrics and straps keyed on, should just balance the crank. The holes for crank-shaft are drilled $\frac{1}{2}$ in and tapped, being recessed on the inside for riveting over when screwed up to the shoulder. The crank-pin is $\frac{7}{16}$ in. thick by $\frac{5}{8}$ in. long with shoulders of $\frac{5}{16}$ in. Each end is screwed to go in the slabs, a small hole of about $\frac{1}{8}$ in. diameter being drilled through the whole to ensure firmness. The distance from centre of pin to centre of crank-shaft is 1 in. When finished it should be tried between the centres of a lathe to

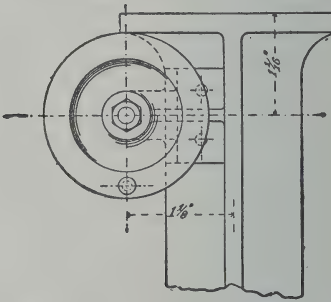


Fig. 130.—Front End Elevation of Engine Link Motion.

make sure it runs true all over. The brasses are so arranged that the collars butt close up when in place, thus preventing any side-play when running.

In order to set eccentrics on the crank-shaft, place the crank on a pair of V blocks, and set the throw up to a square; then set the throw of eccentric sheaves at right angles to the crank-pin for link motion. They are both at an angle of 90° on opposite sides of the crank. The sheaves are made of cast iron, wrought iron, or brass, with a groove cut in to receive the brass strap. The two rods are of forged steel, fitted with flat expansion to bolt on to the strap, and with forked joint to go over the link at the other end.

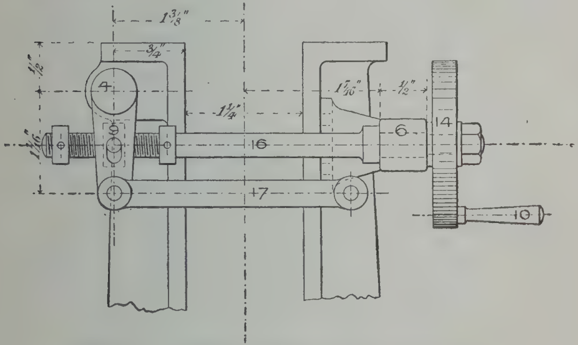


Fig. 131.—Side Elevation of Link Motion

The lubricator, which does away with the necessity of removing the top cover to lubricate the piston, is made of a piece of ⅜-in. brass, turned cup-shape, having a boss to take the plug, and countersunk to take the oil. For turning and grinding in the plug care must be taken to get a good fit, or the steam will leak through. The simplest way is to grind the plug in with very fine sand, and tighten the nut till it works fairly easy.

Fig. 130 represents the front end elevation of the link motion, showing the reversing wheel. Fig. 131 shows a side elevation, giving a view of the reversing levers and the suspension links. The boss cast on the column shown in Fig. 132 is to carry the reversing levers of the link motion. It can either be cast on the column, which is by far the easier way, or it can be tediously made of wrought iron and riveted on. The reversing wheel is shown more clearly in plan and section by Fig. 133; Figs. 134 and 135 are elevational views showing the boss on the column.

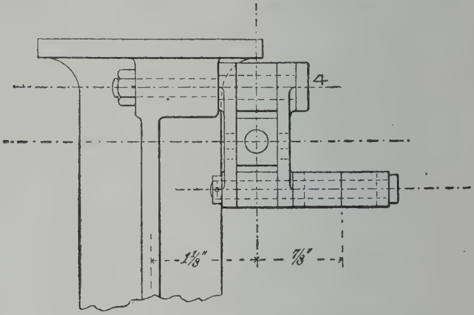


Fig. 132.—Back End Elevation of Link Motion.

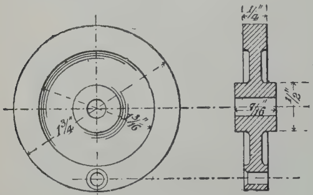


Fig. 133.

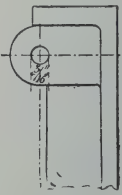


Fig. 134.

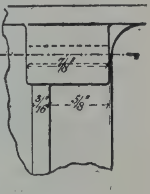


Fig. 135

Fig. 133.—Reversing Wheel; Figs. 134 and 135.—Part of Column showing Boss.

Fig. 136 shows the $\frac{3}{16}$ in. shoulder-pin which carries the two reversing levers shown in Fig. 137. This pin requires great care with regard to length; the part turned $\frac{1}{4}$ in. diameter, measuring $\frac{13}{16}$ in. long, should be made the exact length of the thickness of the two large ends of the reversing levers (Fig. 137), and the length of washer (Figs. 138, 139, and 140), which is $\frac{7}{16}$ in. This gives a total length up to shoulder of $\frac{13}{16}$ in. If it is made the least shade tight or short, the nut will be continually working loose; and if left too long, the levers (Fig. 137) will rattle The remaining length of $1\frac{1}{16}$ in., of course, goes through the lug on the column (Fig. 141), which is $\frac{7}{8}$ in. thick, and, the nut being $\frac{3}{16}$ in., brings the total up to $1\frac{7}{8}$ in.

The reversing levers (Fig. 137) are made of forged

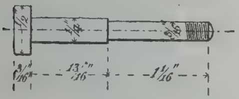


Fig. 136.

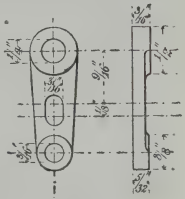


Fig. 137.

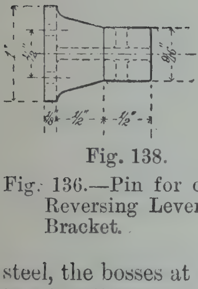


Fig. 138.

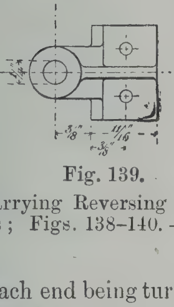


Fig. 139.

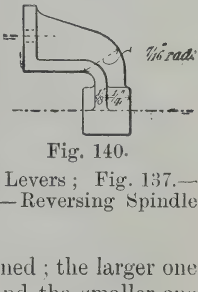


Fig. 140.

Fig. 136.—Pin for carrying Reversing Levers; Fig. 137.—Reversing Levers; Figs. 138–140.—Reversing Spindle Bracket.

steel, the bosses at each end being turned; the larger one is $\frac{1}{2}$ in. diameter with a $\frac{1}{4}$ in. hole, and the smaller one $\frac{3}{8}$ in. diameter with a $\frac{3}{16}$ in. hole. The centres of the holes in the bosses are $1\frac{1}{16}$ in. apart, the slot between being made to carry the lugs on the reversing die (Fig. 142). The best way to make the holes in these levers is to drill the $\frac{1}{4}$ in. hole first, and then drive a piece of quarter iron through both, thus holding the levers securely together; then by drilling the remaining holes through both at once, the centres must be exactly the same. This saves the marking out of the second lever. The hole in centre is slotted to allow for the travel of the die when reversing (Figs. 143 and 144).

The reversing die (Fig. 142) is a piece of mild steel with a lug on each end. These lugs are turned $\frac{3}{16}$ in., and a hole drilled in the centre of the block tapped $\frac{1}{4}$ in. to take the reversing spindle, marked 16 in Fig. 131.

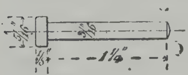


Fig. 141.

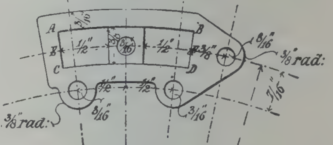


Fig. 143.

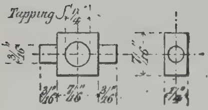


Fig. 142.

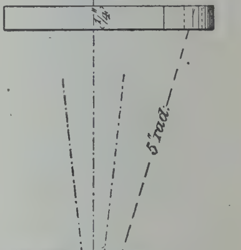


Fig. 144.

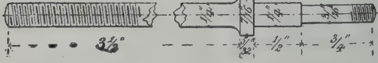


Fig. 145.

Fig. 141.—Pin for Link End; Fig. 142.—Reversing Die; Figs. 143 and 144.—Link and Die; Fig. 145.—Reversing Spindle.

This latter (Fig. 145) is turned all over, leaving a $\frac{7}{16}$ in. shoulder $3\frac{1}{2}$ in. from the end, and screwed $\frac{1}{4}$ in. Whitworth for the first $1\frac{1}{2}$ in., the remainder being turned $\frac{1}{4}$ in. plug up to the collar. Above this for $\frac{1}{2}$ in. it is turned $\frac{1}{4}$ in. diameter, then $\frac{3}{4}$ in. reduced to $\frac{3}{16}$ in. and threaded to receive a nut for holding the reversing wheel in position. This is marked 14 in Fig. 131, and is a solid wheel turned all over, having a boss in centre, $\frac{1}{2}$ in.

diameter by $\frac{1}{16}$ in. thick, with a $\frac{3}{16}$ in. hole to fit the reversing spindle and fitted with a handle (Fig. 146). The handle can be made out of a piece of $\frac{3}{16}$ in. round steel turned taper down to $\frac{1}{8}$ in., leaving a collar $\frac{3}{16}$ in. diameter to butt up to wheel, which is countersunk at the back for riveting the handle. The reversing spindle is held in position by a small single bracket fixed on the column with $\frac{1}{8}$ in. studs, having its centre parallel with centre of slot in reversing levers. This is a right-angled cast-iron bracket (Figs. 138, 139, and 140), having a boss $\frac{1}{2}$ in. diameter bored out $\frac{1}{4}$ in. to take the reversing spindle (Fig. 145), and having in the flange

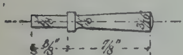


Fig. 146.

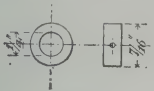


Fig. 147.

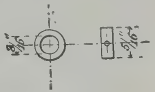


Fig. 148.

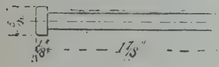


Fig. 149.

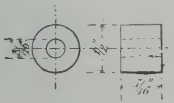


Fig. 150.

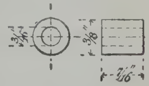


Fig. 151

Fig. 146.—Reversing Wheel Handle; Fig. 147.—Collar for Link End Pin; Fig. 148.—Collar for Reversing Lever Pin; Fig. 149.—Reversing Lever and Suspension Link Pin; Figs. 150 and 151.—Collar for Reversing Levers.

two holes, $\frac{1}{8}$ in. clear, drilled to fit studs in column, centres of which are $\frac{1}{2}$ in. apart. The collars on the reversing spindle (Fig. 147) are $\frac{3}{16}$ in. thick, having a $\frac{1}{4}$ in. hole drilled in centre and tapped to screw on the end of the reversing spindle (Fig. 145). The easiest way of making these is to run two spare $\frac{1}{4}$ in. nuts on a mandrel, and turn off the angles; they will then only require facing down to the right thickness. These collars are set after the engine is erected, and they are fixed with two small taper pins, so that the die in reversing link (Figs. 143 and 144) is at the end of slot when the collars are butting against the reversing die at each end (Fig. 142). The collars shown in Fig. 148 are those belonging to the $\frac{3}{16}$ in. pin (Fig. 149). Fig. 150 is a $\frac{1}{4}$ in. collar to fit on pin (Fig. 136); it goes between the two reversing links to hold them $\frac{7}{16}$ in. apart at the top. Fig. 151 is a collar $\frac{7}{16}$ in. thick, which serves to keep the two links parallel to each other. Fig. 141 shows the pin which fits in the $\frac{3}{16}$ in. hole at the end of link (Figs. 143 and 144), and keeps it parallel by means of the two suspension links (Figs. 152 and 153). Fig. 148 shows the collar for this pin.

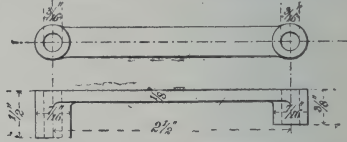


Fig. 152.

Fig. 153.

Figs. 152 and 153.—Suspension Link.

The two suspension links (Figs. 152 and 153) are made of forged steel of $\frac{1}{8}$ in. diameter, with turned boss $\frac{1}{2}$ in. thick at one end and $\frac{3}{8}$ in. thick at the other. These are drilled $\frac{3}{16}$ in. plug size to take the pin and $2\frac{1}{2}$ in. between centres, and the links are polished all over. The heads of the pins are $\frac{1}{4}$ in. thick and $\frac{1}{2}$ in. diameter, and for $\frac{3}{16}$ in. they are $\frac{5}{16}$ in.

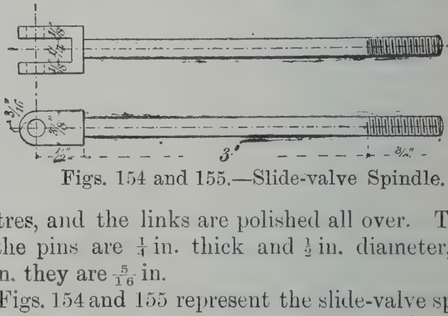


Fig. 154.

Fig. 155.

Figs. 154 and 155.—Slide-valve Spindle.

Figs. 154 and 155 represent the slide-valve spindle. It is $3\frac{1}{2}$ in. from centre of pin-hole to the commencement of thread, which is $\frac{1}{4}$ in. Whitworth, to take the lock-nuts for slide valve. Three-quarters of an inch down the forked joint is $\frac{1}{2}$ in. wide; it is forged solid, and is afterwards filed out with a good rough file. The pin-hole is $\frac{3}{16}$ in. diameter. This pin passes through the die shown in Figs 143 and 144, and must be hardened, as it must sustain a great deal of wear. The width between the jaws of this joint is $\frac{1}{4}$ in., so that they will just span the link, and the depth is $\frac{3}{8}$ in , so as to reach over the $\frac{3}{16}$ in. edge of link to the centre of die

Figs. 156 and 157 show the eccentric rods, of which there are two. They are flat steel forgings $\frac{1}{8}$ in. thick, flattened one end to take the eccentric strap, the flat part being 1 in. long, with two $\frac{1}{8}$ in. clearance holes drilled in them, $\frac{11}{16}$ in. apart to go on studs of strap. The length from end of flat to centre of joint-pin is $3\frac{5}{8}$ in. This joint is thrown out of centre, so that when coupled up the two rods shall not cross each other. The joint is the same as that shown in Fig. 157.

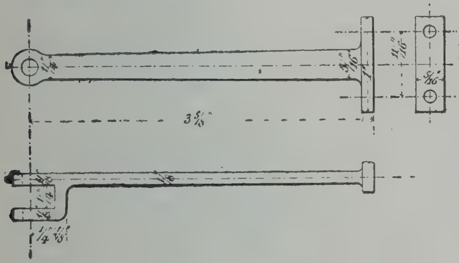


Fig. 156.

Fig. 157.

Figs. 156 and 157.—Eccentric Rods.

Fig. 143 shows the link and die in side elevation, and Fig. 144 shows the plan ; the link and die are both made of mild steel $\frac{1}{4}$ in. in thickness. To make these, take a piece of mild steel $\frac{1}{4}$ in. thick by $2\frac{3}{8}$ in. by $1\frac{1}{16}$ in. ; if not the thickness mentioned, file it down so that the surfaces are quite level and it is the same thickness all over. Try this with outside callipers, draw-file it, and then chalk it over so that the marking-out lines may stand out clearly. The distance from centre of crank to centre of link being 5 in., draw a line on drawing-board or surface-plate ; place centre of link on centre line drawn, care being taken not to shift the link, or different radii will be obtained. Set the compasses at $5\frac{3}{16}$ in., and, having previously found the centre of link, place the point of compasses on centre line, and describe the arc shown at A B, Fig. 143. Then, as the slot is $\frac{3}{8}$ in. wide, reduce the compasses $\frac{3}{8}$ in. and describe the arc C D, having first drawn an arc through the centre as a guide (E F). This marks top and bottom radius of slot, with line through centre. From this central line describe two $\frac{3}{4}$ in. arcs, cutting the top and bottom lines at the points A B and C D. From the centre of crank join the points A C, B D, and it gives the shape of slot correctly. Now take a $4\frac{9}{16}$ in. radius, which will give the centre for eccentric pins. These are each $\frac{1}{2}$ in. from the centre line. The top bar of link is parallel to the slot, and is $\frac{3}{16}$ in. wide, the back end being the same. The pin-hole for the suspension links is on the centre line of link, and is $1\frac{1}{8}$ in. from the centre of slot. The centres for two lugs on bottom of link are $\frac{7}{16}$ in. from centre line of slot. From this hole. which is drilled $\frac{3}{16}$ in. plug, describe an arc with $\frac{3}{8}$ in. radius ; join top line, and this radius will give you the shape for top front end of link. With the same radius, describe two more arcs from centre of eccentric pin-holes. This will give the shape for the two bottom lugs. The easiest way to get the slot cut out is to drill four $\frac{5}{16}$ in. holes within the radius, and then chip them out with a small chisel. From a piece of steel the same thickness as link cut out a piece $\frac{3}{8}$ in. square, and drill a $\frac{3}{16}$ in. hole in the centre in order that the slide-valve spindle joint-pin may fit this die. File on it the same radius as the slot, taking care that it fits well in slot, so that there is no shake or play.

The link motion is now finished, and when put together neatly and well polished, a pretty and most useful model, as shown complete by Fig. 129, p. 128, is the result.

CHAPTER VII.

MAKING A SHOW-CASE FOR A MODEL BOAT.

THE case to be described in this chapter is intended as a strong and well-made air-tight exhibition-case for a model boat that may be as much as 5 ft. 9 in. long, and with its cradle beneath it and with its masts 4 ft. 9 in.

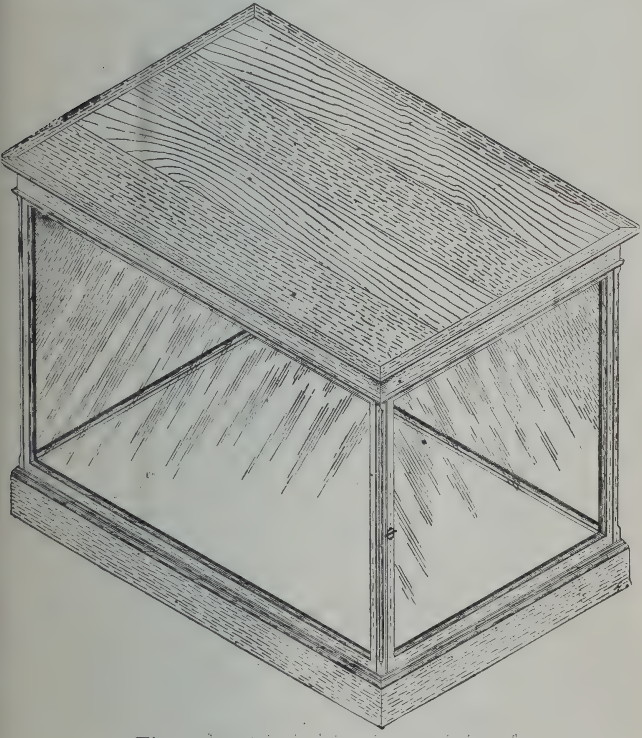


Fig. 158.—Show-case for Model Boat.

high. Its construction may appear too solid for the purpose, but a properly made model of the size indicated, whether a steam or sailing ship, ought certainly to be enclosed in a case with which there is no risk of

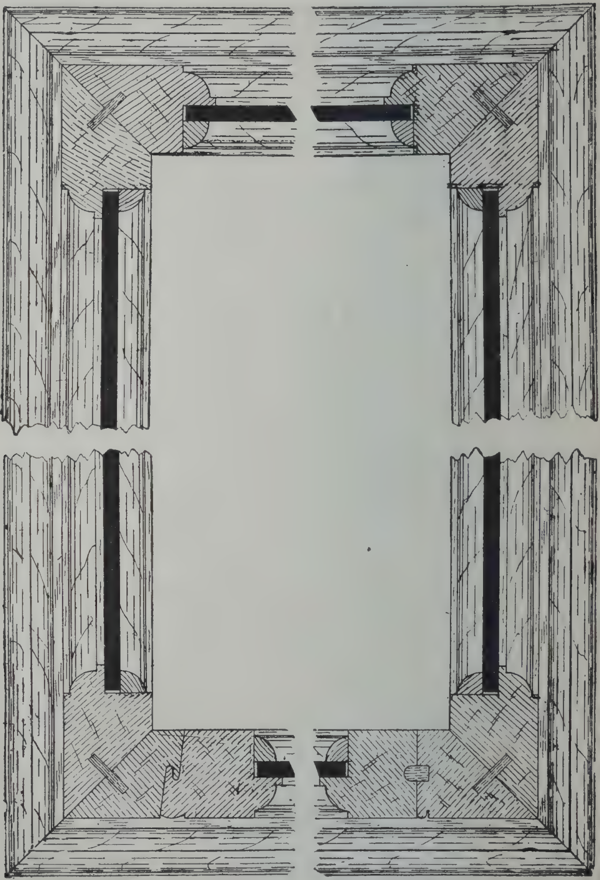


Fig. 159.—Horizontal Section of Case.

the joints coming apart when being moved, and which, at the same time, protects the model from dust and damp.

Fig. 158 is a general or isometric view of a case which is 6 ft. by 4 ft. and 5 ft. high; and as few doorways would admit a case of such size, it had better be made in sections. Fig. 159 illustrates a horizontal section through the case and shows the mitred angles. The base is made entirely separate from the upper parts, and each of the sides is also made separate.

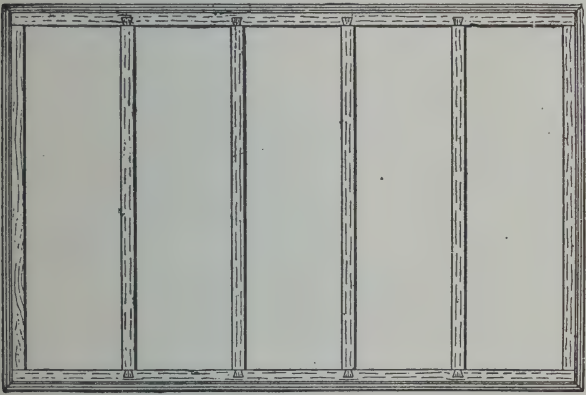


Fig. 160.—Plan of Show-case Base.

The base, shown in plan in Fig. 160, is made of 1½-in. deal. The four intermediate rails should be 8 in. high, and the ends and sides 7⅝ in. high (see Fig. 81). By making the sides and ends narrower than the rails, room is allowed for a piece of mahogany veneer to be glued on, after which they will be of the same width as the rails. The mahogany skirting is 8 in. wide and 1 in. thick. The intermediate rails must be dovetailed two-thirds of the distance down from the top edge, as shown in Fig. 161, and three dovetails should be put into the angles formed by the back and sides. The skirting must be tongued to the deal sides, and also have a tongue in the mitre at the angles. The cornice may be made of mahogany, or deal faced with mahogany; the latter, if well made and of good dry material, will be superior to a solid mahogany fascia. The cornice moulding should be tongued to the fascia; also screwed from the inside before fixing the cover board on top; the neck moulding should also be screwed on from the inside with very fine screws. In framing up the sashes, sufficient should be left on each end of the stiles to allow a tenon to be cut thereon; this will fit into a mortise prepared in the centre of the top edge of the base and the face edge of the fascia. Face up four pieces of 1½-in. deal, square one edge, and gauge them to 1⅜ in. in thickness and 7⅝ in. in width. The deal base must be of the same thickness as the sash (1⅜ in.) in order that the edge of the skirting may show the same projection all round. Plough the centre of the face side for a ⅛-in. cross tongue, and ½ in. deep to

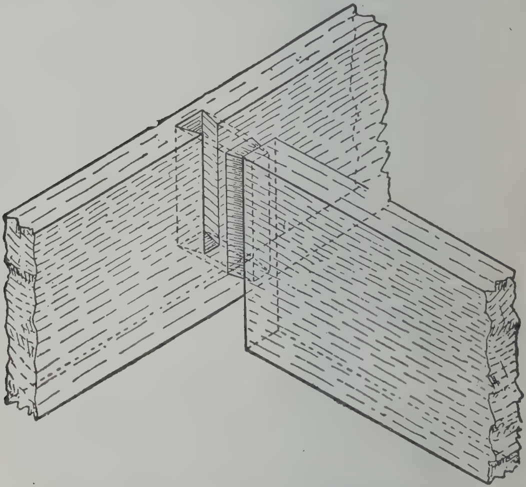


Fig. 161.—Dovetailed Joint of Base Rails.

receive the tongue of the skirting. Prepare four pieces of mahogany 1⅜ in. wide by ⅜ in. finished thickness, and glue these to the upper and face edges to make the width 8 in. When these are dry, level off and plough down inside the proper depth to receive the air-tight fillet. Cut off the two sides 5 ft. 9¼ in. long, to allow for the skirting at each end; also cut two ends 3ft. 9¼ in., and gauge on both inner and outer faces of each of the four pieces the thickness of the sides (1⅜ in.).

Mark out three dovetails of moderate size and cut the mortises; put the end of the side to the inner face of end, and mark on the pin by running a fine saw down the cut for the mortise. Then cut outside the saw mark, leaving sufficient to keep the pin tight; try the work together, and, if it fits, proceed with the three other angles in the same manner. Set out five equal spaces along the inner face of the sides, allowing 1½ in. between each for the intermediate rails, which may be left with just the roughness taken off them. Cut them off to 3 ft. 9½ in., then gauge on 1 in. each end for forming the dovetail (Fig. 161). Cut the pin of dovetail about 5½ in. deep from the top edge, leaving a square shoulder. Mark the pin in the space left for it on the side, and inside the line marked cut out to the depth of the pin. Cut all in the same manner and fit and glue them together. If the dovetails do not fit accurately, put a good-sized nail in between the pins, and so bring up the shoulders. Be careful in fitting together that the rails are exactly the right length, and do not bulge the sides out or make them hollow. Fit everything together dry, and ascertain if all is correct before glueing up. Level off the angles and tightly fit the air-tight fillet into the deal frame, previously cutting out sufficient at the sides to allow it to pass. The ends can be fitted without any trouble. When once they are glued and the base finished, there is no chance of their coming away, as the bottom or top of the base fits closely. Glue them in and put on hand-screws to pull them up at the joints. Fix on the rebated block, leaving sufficient above it to take the pine top of the base and be level with the edge of the fillet. This deal blocking may be in one length at the ends and well screwed to the frame; but at the sides it must be cut in between the rails unless they have been previously notched to receive the block. A pine top, 5 ft. 7 in. by 3 ft. 7 in., should next be cut in between the fillets. Four dry 11-in. pine boards jointed together will make the desired width, and the top may be screwed down to the rails and to the blocking. If, however, the material is at all green, it will be better to button it down to the rails. The joint it leaves can then be filled up with a glued slip; if nailed down, it would probably split in several places.

The mahogany for the outer face and skirting should be glued on to the deal frame before the pine top is fixed. In preparing it, take care to have the figure of the grain running the right way. Gauge the skirting to about $\frac{7}{8}$ in. thick and 8 in. wide. Mark the shape of the moulding on the ends, work the hollow, the round, and the quirk, and clean it up with fine glass-paper to a good surface. Gauge down the back side to the depth of the plough groove on the deal frame, and plough to suit it; and when all four pieces are prepared, traverse the deal frame, also the mahogany skirting, with a toothing plane so that a good sound joint is obtained. A toothing plane has a cutting iron the edge of which is similar to the teeth of a dovetail-saw, and is chiefly used by cabinet-makers for veneering. It makes a number of small furrows on both faces of the material, and so affords a good key for the glue. Mark the length of the sides of the deal frame on the back side of the mahogany skirting, which will be the shortest point of the mitre. Cut these mitres, and glue blocks on at each angle, say three on each, perfectly square from the mitre, for fixing the hand screws on to pull it up when glued. On the face side, plough across the mitre to receive an eighth tongue, stopping the groove below the moulding. When this is done, try all together on the deal frame,

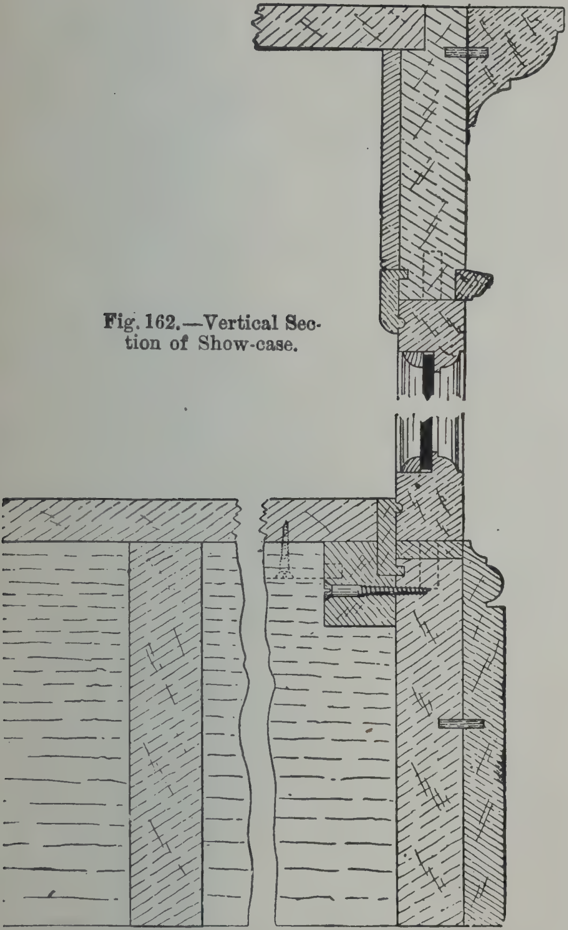


Fig. 162.—Vertical Section of Show-case.

holding the mitre together by means of hand screws, when, if all the mitres come up nicely, the skirting may be glued on. First glue on one side, holding it securely by placing hand screws down from the top edge and clasping the deal and mahogany together, then work round in the same way until all four pieces are fixed.

The cornice and fascia, of which the upper portion of Fig. 162 is a part section, should be made either of good dry mahogany, or of pine with a mahogany face. First take two pieces of mahogany 6 ft. long, and two pieces 4 ft. long, both 6 in. wide and $1\frac{1}{2}$ in. thick. Face up and gauge them to 6 in. wide and $1\frac{3}{8}$ in. thick, and form a rebate on the top edge of the inner face $\frac{1}{2}$ in. by $\frac{7}{8}$ in. deep to receive the top or cover board. Plough the bottom edge on the inner face to receive the air-tight fillet, rebate out $\frac{3}{16}$ in. deep on the bottom edge of face side to receive the neck moulding, then plough the upper edge of the face to receive the tongue of the cornice moulding. Should this facia be prepared out of pine and veneered, the veneer should be the same thickness as the depth of the rebate for the neck moulding. It would then form a rebate in itself, also the cornice would require to be that much thicker on the back side to fit into the rebate. When this is done, cut rods to the extreme length and width of the case; this will be to the short point of the mitre. Cut off each piece to the lengths of the rods and mitre them, then plough across the mitres to receive the tongues and glue blocks on the face to pull the mitres up. When these have been made to fit, and the rim is perfectly square, take it to pieces and mitre in the air-tight fillets, which should be glued in and allowed to set before the fascia is put together permanently. No hard and fast line can be drawn with reference to the shape of the cornice moulding which should be prepared next. Plough it on the back to receive a tongue, and mitre it round the cornice and glue it in its place, also fixing it with fine screws from the back side, or putting fine panel pins in the square portion of the moulding on the face. When the glue is set, take off the hand screws, etc., and put on the cover board, which should be of dry pine, and fix it with fine screws from the top. Turn up the cornice on its top, and fit in and fix with panel pins pieces of pine the

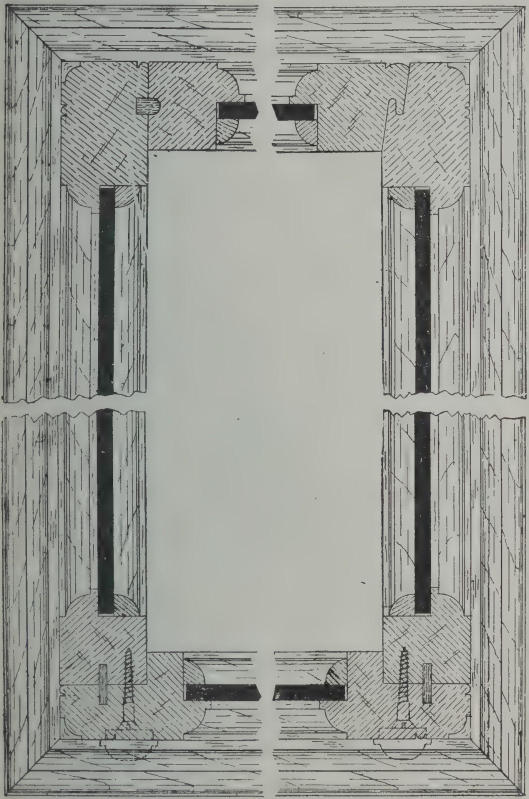


Fig. 163.—Horizontal Section of Case made in Sections.

same thickness as the air-tight fillet. The material for the side sashes must be good, straight-grained mahogany, free from knots. Measure off what is required—namely, eight stiles 4 ft. 2 in. long, four rails 4 ft. long, and four rails 6 ft. long and of the requisite widths, as shown on the setting out. The method of jointing the angles of the sashes is shown by Fig. 163; these need very careful fitting. Hook joints must be worked on the side of one of the front sash stiles, and on the shutting stile of the side sash, the air-tight bead being formed on the hanging stile. Prepare the four stiles, 2½ in. wide, 1⅝ in. thick, face them up true and straight, and gauge them to 2⅜ in. finished size. Also prepare two rails 6 ft. long, 1½ in. full finished width, and 1⅝ in. thick, and two of the same length 1⅞ in. bare finished width. Set out these two sashes 5 ft. 10¼ in. to outer edge, which is the exact width of the deal frame and fascia. In setting out the rails, therefore, the distance between the shoulder lines should be 5 ft. 6¼ in. The tenons on these rails should be cut about 1½ in. in length, as, if mortised through end grain, they look unsightly; the mortises should be stopped accordingly, so that they do not go through the stile. A tenon going two-thirds through the stile, if well fitted and glued, will be a perfectly sound and lasting joint. Work the moulding and rebate as shown in Fig. 164. Rebate out the two end stiles in pairs, 1⅝ in. on and ½ in. deep; plough in the centre for an eighth tongue, and work the bead on the edge, also the one on the face which is sunk. Square the moulding lines of the top and bottom rails of sash across the face, and work the ovolo moulding on the angle, stopping it at the lines mentioned with a bevelled stop, as shown in Fig. 164. Be careful to leave sufficient on either end of the stiles for forming the 1 in. tenons. The hook joint on the left-hand stile must be worked, as previously described, with a 1½-in. hook-joint plane. It is imperative that the stiles should be well fixed, in order that the whole thing may be rigid when finished. Work the ovolo moulding on the angle and stop it as before explained. In preparing the hanging stile, all that will be necessary beyond the usual procedure will be to plough for the air-tight bead.

Before glueing up the side sashes, make sure that the outer edges of the rails are perfectly square, so that they form a perfect joint when in their places. After they have been glued up and allowed to dry, clean off on both sides and form the tenons on each end of the stiles, the shoulders being the outer edge of the rails ; then work on the inside the hollow to receive the round of the air-tight fillet. If any difficulty is experienced in getting these sashes in their places, shorten the tenon to ¾ in. For the sash for the opposite end (Fig. 163), the material required will be two stiles 1⅜ in. square, one rail 1½ in. by 1⅜ in., and another 1⅞ in. by 1⅜ in. Frame them together, plough the outer edges for the tongue in the rebate, and form the tenons in all respects similar to those for the side sashes. Next prepare the front hanging sash with the hook joint and bead stile, allowing the stile sufficient width to form the joint. Put a double tenon on the ends of the left-hand rails. No tenons will be required on the stiles. When all the sashes have been prepared and fitted, put them into the mortises prepared for them. The fixed sash at the end may be secured by means of screws through the stile of the side sash, turned pateræ being provided to cover the screw-heads. This joint should not be glued unless it is to be fixed permanently, as the tongued joint itself is,

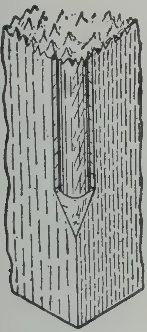


Fig. 164.—Stopped Moulding on Angles of Case.

if properly made, sufficient to exclude all air. Fix both side sashes in this way and drop on the cornice and fit in the hanging sash.

The model boat, supported in its cradle or by another suitable device, can now be slid in from the side, and, if necessary, secured by screws. Various means of securing and supporting the model will suggest themselves. A suggestion as to the shape of a suitable stand is given on p. 62. Now put in the glass, which should fit tightly and be bedded on a thin layer of putty. Fix packing pieces where required to keep the case square and the frame perfectly straight. Fix on the beads with fine panel pins, clean off all superfluous putty; the case will then be ready for polishing. The inside of the top should be lined with white lining-paper, the bottom with velvet plush or other suitable material. Of course glass may be substituted for the wood top if desired.

It is unnecessary to say much with regard to the many ways in which the case can be finished. Mahogany or inferior wood faced with mahogany has been mentioned as the best material of which to construct the case, and if this wood has been employed the only suitable method of finishing will be to French polish it. If commoner wood has been used it may be stained in imitation of mahogany by rubbing over it with a rag two coats of a mixture of burnt sienna, ground in water, with stale beer. When dry, sandpaper smooth and apply several coats of spirit varnish with which a little Bismarck brown has been mixed; or, instead of varnishing, the wood may be French polished. If the case has been made, say, of good pine, it could with advantage be given a glossy black polish which certainly enhances the appearance of any case. To apply the polish proceed as follows :—

The parts to be polished must be cleaned up with fine glasspaper, all unevennesses, such as marks of the plane-iron, etc., being carefully removed, as no surface polish, especially on flat surfaces, shows defects more clearly than black. The ingredients required for polishing are French stain, linseed oil, plaster-of-Paris, spirit black, button polish, and methylated spirit. The parts to be polished should be covered with the French stain, which, when dry, is a blue black, and then with plaster-of-Paris mixed with water to the consistency of thick cream. When nearly dry, rub off as much as possible, leaving the surface clean, the grain only being filled with the paste. Linseed oil is next applied with a piece of old rag. A gill of button polish is then dissolved in ¼ oz. of spirit black, and applied in the usual way with a cotton-wool rubber. A little linseed oil must be used on the rubber to make it work freely. When a good body has been obtained, any parts which are ropy may be levelled with a piece of old, fine glasspaper and a little linseed oil. The wool rubber is then covered with a piece of old linen and the final coat is given, using as little oil as possible on the rubber. When a satisfactory surface has been obtained, the linseed oil remaining in the polish must be killed, or the work will be dull. Make a new rubber with cotton-wool and a piece of clean linen, damp it slightly with methylated spirit, and use when giving the final coat; a highly glossy finish should result. If too much spirit is used, all the polish will be taken off.

The following is a suggestion as to how a model vessel enclosed in a box may be made to travel round in a circle, at the same time rising and falling as if at sea. The device is illustrated by Figs. 165 to 168, Fig. 165 being a sectional elevation, Fig. 166 a plan, and Figs. 167 and 168 enlarged views of the vessel and lines. No sizes are given, as these will have to suit the model boat, which, however, must not be large if driven by clockwork. Having obtained a vessel, A, of a suitable size, fasten two supports, *a a*, at each end, connecting them by a stiffening piece, *b*, with a narrow vertical slot, *c*, in it of such a length that the finger, *d*, Figs. 165, 166, and 167, though keeping at the same vertical height, may continually push the boat round in a circle, though the latter keeps rising and falling. The sea may be represented by an evenly corrugated circular sheet of painted iron, B. If the corrugations are very deep, more power will be required than the works of a clock will give.

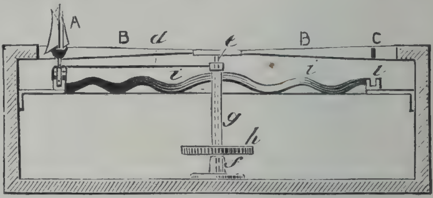


Fig. 165.

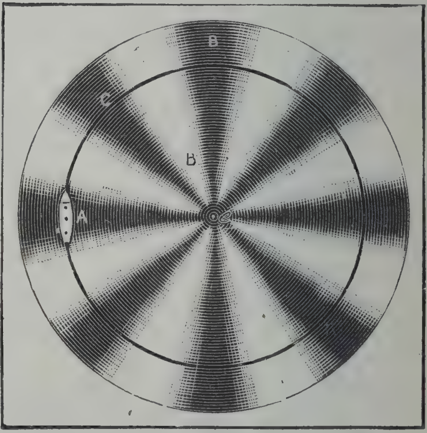


Fig. 166.

Figs. 165 and 166.—Device for Imitating Wave Motion.

Cut out a circular disc having a slot, C; through this the boat supports pass. The central portion must be carried on the turned pillar, *e*, rigidly fixed into support, *f*, fastened to the bottom of the box. Below the slot, C, a brass channel rail, *i*, should run all the way round, every point in its circumference being an equal distance from and exactly underneath the surface of the sea at the slot. This rail, *i*, is so constructed that by means of two broad wheels, *j*, with central projections on the rim to fit the channel rail, the boat is kept perfectly steady. The end of the finger, *d*, should pass through the slot, *c*,

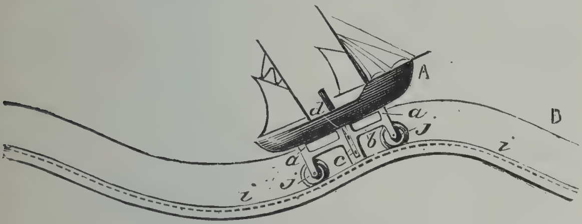


Fig. 167.—Model Boat Riding Artificially.

with a washer fixed on either side, just allowing the end of *d* to pass easily up and down the slot, but with as little shake as possible. The finger, *d*, must be fixed to

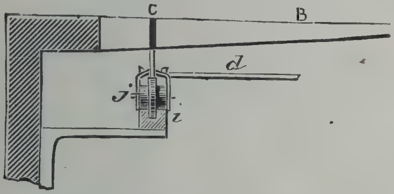


Fig. 168.—Section of Device for Imitating Wave Motion.

the top of the sleeve, *g*, of spur wheel, *h*, the sleeve and wheel being drilled to fit pillar, *e*, and turn round on it. The wheel, *h*, can be placed in any suitable position as regards height on the sleeve, *g*, so that it will gear with the last of the train of clockwork wheels. The clockworks must be arranged to suit the power required, some of the quick-running weak wheels being taken out.

The method just described is one of the simplest by which a good imitation of the waves of the sea may be gained. There are many other methods of producing this illusion, but there is not sufficient space for a description of them. It may be mentioned, however, that if a small model boat is merely placed within a suitable case whose floor has been treated to represent the sea, a good effect is produced, even when the movement of either sea or boat is not arranged for. The waves may be made out of a piece of tissue paper or cambric crumpled and painted to represent form and colour as naturally as possible. To produce a fair imitation sea, cut up the surface of a piece of soft wood, sufficiently large to cover the bottom of the show-case, with a chisel and gouge so as to turn up a succession of lines of chips of irregular height, following roughly the formation of the surface of a sea. Damp a piece of cambric and press it into the wood with a stiff-haired brush, afterwards coating the outer surface with starch paste and allowing it to dry. Complete the sea by daubing on green and white distemper paint.

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